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AEROSPACE MEDICINE AND BIOLOGY

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AEROSPACE MEDICINE AND BIOLOGY

A CONTINUING BIBLIOGRAPHY WITH INDEXES

NASA National Aeronautics and Space Administration
Scientific and Technical Information Program
Washington, DC 1993

This publication was prepared by the NASA Center for AeroSpace Information,
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INTRODUCTION

This issue of *Aerospace Medicine and Biology* (NASA SP-7011) lists 119 reports, articles, and other documents recently announced in the NASA STI Database. The first issue of *Aerospace Medicine and Biology* was published in July 1964.

Accession numbers cited in this issue include:

Scientific and Technical Aerospace Reports (STAR) (N-10000 Series)	None for this issue
International Aerospace Abstracts (IAA) (A-10000 Series)	A93-49081 — A93-52650

In its subject coverage, *Aerospace Medicine and Biology* concentrates on the biological, physiological, psychological, and environmental effects to which humans are subjected during and following simulated or actual flight in the Earth's atmosphere or in interplanetary space. References describing similar effects on biological organisms of lower order are also included. Such related topics as sanitary problems, pharmacology, toxicology, safety and survival, life support systems, exobiology, and personnel factors receive appropriate attention. Applied research receives the most emphasis, but references to fundamental studies and theoretical principles related to experimental development also qualify for inclusion.

Each entry in the publication consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged by *STAR* categories 51 through 55, the Life Sciences division. The citations include the original accession numbers from the respective announcement journals.

Seven indexes—subject, personal author, corporate source, foreign technology, contract number, report number, and accession number—are included.

A cumulative index for 1993 will be published in early 1994.

Information on availability of documents listed, addresses of organizations, and CASI price schedules are located at the back of this issue.

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Category 54 Man/System Technology and Life Support 389
Includes human engineering; biotechnology; and space suits and protective clothing.

Category 55 Space Biology N.A.
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TYPICAL REPORT CITATION AND ABSTRACT

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ACCESSION NUMBER → **N93-12195** *# Lockheed Engineering and Sciences, Co., Houston, TX. ← CORPORATE SOURCE

TITLE → **ASTRONAUT CANDIDATE STRENGTH MEASUREMENT USING THE CYBEX 2 AND THE LIDO MULTI-JOINT 2 DYNAMOMETERS Final Report**

AUTHORS → AMY E. CARROLL and ROBERT P. WILMINGTON May 1992 ← PUBLICATION DATE

CONTRACT NUMBER → (Contract NAS9-17900)

REPORT NUMBERS → (NASA-CR-185679; NAS 1.26:185679; LESC-30277) Avail: CASI ← AVAILABILITY

PRICE CODE → HC A03/MF A01

The Anthropometry and Biomechanics Laboratory in the man-Systems division at NASA's Johnson Space Center has as one of its responsibilities the anthropometry and strength measurement data collection of astronaut candidates. The anthropometry data is used to ensure that the astronaut candidates are within the height restrictions for space vehicle and space suit design requirments, for example. The strength data is used to help detect abnormalities or isolate injuries to muscle groups that could jeopardize the astronauts' safety. The Cybex II Dynamometer has been used for strength measurements from 1985 through 1991. The Cybex II was one of the first instruments of its kind to measure strength and similarity of muscle groups by isolating the specific joint of interest. In November 1991, a LIDO Multi-Joint II Dynamometer was purchased to upgrade the strength measurement data collection capability of the Anthropometry and Biomechanics Laboratory. The LIDO Multi-Joint II Dynamometer design offers several advantages over the Cybex II Dynamometer including a more sophisticated method of joint isolation and a more accurate and efficient computer based data collection system. Author

TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT

ACCESSION NUMBER → **A93-11150**

TITLE → **STUDIES TOWARDS THE CRYSTALLIZATION OF THE ROD VISUAL PIGMENT RHODOPSIN**

AUTHORS → W. J. DE GRIP, J. VAN OOSTRUM, and G. L. J. DE CALUWE

AUTHORS' AFFILIATION → (Nigmegen Catholic Univ., Netherlands) Journal of Crystal Growth (ISSN 0022-0248) vol. 122, no. 1-4 Aug. 1992 ← JOURNAL TITLE ← PUBLICATION DATE
p. 375-384. Research supported by SRON refs

CONTRACT NUMBER → (Contract NWO-SON-328-050)

Copyright

Results are presented of crystallization experiments on bovine rhodopsin, which established a restricted range of conditions which reproducibly yield rhodopsin crystals. Several parameters were optimized, including the detergent, the precipitant, additives, and pH. The crystals obtained so far are too small (less than 50 microns in any direction) or of insufficient order to allow high-resolution diffraction analysis. Several approaches are proposed for improving the average size, stability, and order of the rhodopsin crystals. I. S.

AEROSPACE MEDICINE AND BIOLOGY

A Continuing Bibliography (Suppl. 382)

December 1993

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LIFE SCIENCES (GENERAL)

A93-49179
EFFECT OF CHRONIC CENTRIFUGATION ON IN VITRO FERTILIZATION AND EARLY DEVELOPMENT IN MICE OVA
MASAO ITO, RURIKO MARU, TAKASHI MAEDA, ESTER SANADA, TAKAICHI MANO, SHINICHI HORIGOME (Nihon Univ., Tokyo, Japan), KENICHI IWASAKI (Nihon Univ. Hospital, Tokyo, Japan), YUICHI KAMEYAMA, YOSHIRO ISHIJIMA (Tokyo Univ. of Agriculture, Abashiri, Japan), and KAZUYOSHI YAJIMA (Nihon Univ., Tokyo, Japan) Japanese Journal of Aerospace and Environmental Medicine (ISSN 0387-0723) vol. 30, no. 1 March 1993 p. 19-25. In JAPANESE refs

It is reported that fertilization rate was over for mice ova subjected to 0.6 and 1.2 G of acceleration in centrifuges and in those receiving 1.8 G and over. In the former group ova ceased to grow mostly at metaphase II and sperm penetration was prevented. In the latter group, while sperms penetrated the ovular cytoplasm and the nuclei reached anaphase or telophase, polyspermy and abnormalities were frequent. Centrifugation at 2 G or less had no effect on in vitro growth of two-cell ova into blastocysts, but the cell number of embryos thus produced was significantly smaller than in controls. In ova receiving 3.6 or 4.0 G, most failed to grow to blastocysts and those that did were smaller than 60 cells. AIAA

A93-49206* National Aeronautics and Space Administration, Washington, DC.
CLINOSTATS AND CENTRIFUGES: THEIR USE, VALUE, AND LIMITATIONS IN GRAVITATIONAL BIOLOGICAL RESEARCH; SYMPOSIUM, WASHINGTON, OCT. 19, 1991, REPORT
THORA W. HALSTEAD, ED. (NASA, Washington), PAUL TODD, ED. (Colorado Univ., Boulder), and JANET V. POWERS, ED. (George Washington Univ., Washington) ASGSB Bulletin (ISSN 0898-4697) vol. 5, no. 2 Oct. 1992 91 p. For individual items see A93-49207 to A93-49214
Copyright

The present volume addresses physical phenomena and effects associated with clinostat and centrifuge operations as well as their physiological effects. Particular attention is given to the simulation of the gravity conditions on the ground, the internal dynamics of slowly rotating biological systems, and qualitative and quantitative aspects of the fast-rotating clinostat as a research tool. Also discussed are the development and use of centrifuges in gravitational biology, the use of centrifuges in plant gravitational biology and a comparison of ground-based and flight experiment results, the ability of clinostat to mimic the effect of microgravity on plant cells and organs, and the impact of altered gravity conditions on early EGF-induced signal transduction in human epidermal A431 cells. AIAA

A93-49207
THE SIMULATION OF MICROGRAVITY CONDITIONS ON THE GROUND
GUENTER ALBRECHT-BUEHLER (Northwestern Univ., Chicago, IL) ASGSB Bulletin (ISSN 0898-4697) vol. 5, no. 2 Oct. 1992 p. 3-10. Clinostats and centrifuges: Their use, value, and limitations in gravitational biological research; Symposium, Washington, Oct. 19, 1991, Report. A93-49206 21-51 Research supported by U.S. Army
(Contract N0014-89-J-1700)
Copyright

Consideration is given to weightlessness defined as the condition where the acceleration of an object is independent of its mass. It is argued that the clinostat is very limited as a simulator of microgravity because it generates centrifugal forces and particle oscillations with mass dependent amplitudes of speed and phase shifts relative to the clinorotation. The clinostat is unable to remove globally the scalar effects of gravity and generates more convective mixing of the gaseous or liquid environment of the test object, rather than eliminating it, as would true weightlessness. It is considered to be mandatory to include in simulations of microgravity control experiment for testing the influence of the chamber wall and the media on cells. AIAA

A93-49208* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
THE INTERNAL DYNAMICS OF SLOWLY ROTATING BIOLOGICAL SYSTEMS
JOHN O. KESSLER (Arizona Univ., Tucson) ASGSB Bulletin (ISSN 0898-4697) vol. 5, no. 2 Oct. 1992 p. 11-21. Clinostats and centrifuges: Their use, value, and limitations in gravitational biological research; Symposium, Washington, Oct. 19, 1991, Report. A93-49206 21-51 Research supported by Arizon Univ. Foundation refs
(Contract NAG9-442; NSF INT-89-22466)
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The structure and the dynamics of biological systems are complex. Steady gravitational forces that act on organisms cause hydrostatic pressure gradients, stress in solid components, and ordering of movable subsystems according to density. Rotation induces internal motion; it also stresses and or deforms regions of attachment and containment. The disrupted gravitationally ordered layers of movable entities are replaced by their orbital movements. New ordering geometries may arise also, especially if fluids of various densities occur. One novel result obtained concerns the application of scheduled variation of clinostat rotation rates to the management of intracellular particle trajectories. Rotation and its consequences are discussed in terms of scaling factors for parameters such as time, derived from mathematical models for simple rotating mechanical systems.

A93-49209
SOME QUALITATIVE AND QUANTITATIVE ASPECTS OF THE FAST-ROTATING CLINOSTAT AS A RESEARCH TOOL
WOLFGANG BRIEGLEB (DLR, Inst. fuer Flugmedizin, Cologne, Germany) ASGSB Bulletin (ISSN 0898-4697) vol. 5, no. 2 Oct. 1992 p. 23-30. Clinostats and centrifuges: Their use, value, and limitations in gravitational biological research; Symposium, Washington, Oct. 19, 1991, Report. A93-49206 21-51 refs
Copyright

A method of fast rotating clinostat aimed at investigating the effects of weightlessness on small living objects is described

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qualitatively using a macroscopic functional model and empirical results from a fast-rotating clinostat microscope. A geometrical description of the principle in the macro- and microrange of the fast clinostat is also presented. The fast clinostat affects movements of relatively dense liquid bodies, or rigid particles under suspension. The fast clinostat makes it possible to prevent passive relative movements or tensions within a suspension. AIAA

A93-49210
CENTRIFUGES - THEIR DEVELOPMENT AND USE IN GRAVITATIONAL BIOLOGY
ARTHUR H. SMITH (California Univ., Davis) ASGSB Bulletin (ISSN 0898-4697) vol. 5, no. 2 Oct. 1992 p. 33-41. Clinostats and centrifuges: Their use, value, and limitations in gravitational biological research; Symposium, Washington, Oct. 19, 1991, Report. A93-49206 21-51 refs
Copyright

The nature of centrifuges and their use in biological research are reviewed historically. Centrifuges are particularly important to research in gravitational biology because the inertial (centrifugal) forces developed by motion can be combined with gravitation to produce gravitational fields other than Earth gravity. In orbiting satellites centrifuges can provide an onboard 1 g environment. A similarity of results from the orbiting and ground-based 1 g controls will provide an essential assurance that the biological responses to the spacecraft environment are the result of changes in the gravitational field. The relationship of biological responses to gravitational fields greater or less than Earth gravity is considered. However, at present there is insufficient equivalent information to decide whether there is or is not a proportionality of response to fields stronger or weaker than Earth gravity.

A93-49211
CENTRIFUGES - EVOLUTION OF THEIR USES IN PLANT GRAVITATIONAL BIOLOGY AND NEW DIRECTIONS FOR RESEARCH ON THE GROUND AND IN SPACEFLIGHT
ALLAN H. BROWN (Pennsylvania Univ., Philadelphia) ASGSB Bulletin (ISSN 0898-4697) vol. 5, no. 2 Oct. 1992 p. 43-57. Clinostats and centrifuges: Their use, value, and limitations in gravitational biological research; Symposium, Washington, Oct. 19, 1991, Report. A93-49206 21-51 refs
Copyright

The use of centrifugation as a tool for exploring qualitative and quantitative features of plant responses to gravity is reviewed. Experiments studied how plants perceive and respond to gravitational stimuli by manipulating the force or acceleration vector direction and magnitude. It is argued that the use of centrifuge and clinostat or centrifuge and spacecraft is an especially powerful research technique for both ground- and space-based experiments. AIAA

A93-49212
THE FAST ROTATING CLINOSTAT - A HISTORY OF ITS USE IN GRAVITATIONAL BIOLOGY AND A COMPARISON OF GROUND-BASED AND FLIGHT EXPERIMENT RESULTS
MARIANNE COGOLI (Zuerich, Eidgenoessische Technische Hochschule, Zurich, Switzerland) ASGSB Bulletin (ISSN 0898-4697) vol. 5, no. 2 Oct. 1992 p. 59-67. Clinostats and centrifuges: Their use, value, and limitations in gravitational biological research; Symposium, Washington, Oct. 19, 1991, Report. A93-49206 21-51 refs
Copyright

The fast rotating clinostat has been used in gravitational biology since 1965 to investigate effects of simulated microgravity. Using a microscope, the behavior of cells and organelles within the cells under microgravity conditions can be directly observed during rotation. Experiments with several mammalian cells and unicellular organisms have shown that different cellular functions are affected in simulated microgravity. Almost no changes were noted in the area of developmental biology. A comparison of results from the fast routing clinostat and flight experiments reveals that the clinostat is a valuable tool to evaluate an organism's sensitivity to gravity changes. Therefore, a biological object proposed for a flight experiment should first be investigated in the clinostat before it is selected. This is especially true in the use of single cells and unicellular organisms.

A93-49213
HOW WELL DOES THE CLINOSTAT MIMIC THE EFFECT OF MICROGRAVITY ON PLANT CELLS AND ORGANS?
ANDREAS SIEVERS and ZYGMUNT HEJNOWICZ (Bonn Univ., Germany) ASGSB Bulletin (ISSN 0898-4697) vol. 5, no. 2 Oct. 1992 p. 69-75. Clinostats and centrifuges: Their use, value, and limitations in gravitational biological research; Symposium, Washington, Oct. 19, 1991, Report. A93-49206 21-51 Research supported by DARA and Ministerium fuer Wissenschaft und Forschung refs
Copyright

The effect of clinostatting and microgravity on plant cells and organs is considered on the basis of distinguishing two types of gravistimulation: static and dynamic. The former is switched off both by clinostatting and microgravity, the latter is switched off by microgravity but occurs inevitably during clinostatting and may be perceived by cells if the rotation is not fast enough. Effects of clinostatting and microgravity on different examples of static gravistimulation (tonic effects, formation of compression wood, growth of 'grass nodes', compensation of epinasty, stabilization of cellular polarity) are considered. The mechanism of the dynamic stimulation is presented; it is related to the displacement of the gravity sensing masses in the cell containing them, and involves disturbance of cytoskeletal tension. The low threshold for gravity perception and short minimal time of dynamic stimulation are emphasized. Only a relatively fast rotating clinostat, on which the radial distance of the cells from the rotational axis is small enough to keep the centrifugal force low, can effectively compensate gravity. However, one must take into account the extreme sensitivity of plants to mechanical stresses that may appear during clinostatting at different levels of plant organization.

A93-49214
ALTERED GRAVITY CONDITIONS AFFECT EARLY EGF-INDUCED SIGNAL TRANSDUCTION IN HUMAN EPIDERMAL A431 CELLS
PHILIP J. RIJKEN, ROLF P. DE GROOT, WIEBE KRUIJER, ARIE J. VERKLEIJ, JOHANNES BOONSTRA, and SIEGFRIED W. DE LAAT (Utrecht Univ.; Netherlands Inst. for Developmental Biology, Utrecht) ASGSB Bulletin (ISSN 0898-4697) vol. 5, no. 2 Oct. 1992 p. 77-82. Clinostats and centrifuges: Their use, value, and limitations in gravitational biological research; Symposium, Washington, Oct. 19, 1991, Report. A93-49206 21-51 refs
(Contract NWO-783-380-100)
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The effects of various gravity conditions, created by a centrifuge, a fast-rotating clinostat, and a sounding rocket, on the cellular responses to epidermal growth factor (EGF) are compared. The early responses evoked by EGF include receptor clustering, cell rounding, and gene expression. Particular attention is given to signalling pathways as induced by 12-O-tetradecanoylphorbol-13-acetate, forskolin, and A23187 which bypass the EGF receptor but mimic the partial activation of signal transduction pathways. It is concluded that gravity affects specific components of early EGF-induced signal transduction. Both sounding rocket and clinostats provide useful tools to establish the sensitivity of cellular processes to gravity. AIAA

A93-49224
ACCELERATION-INDUCED EFFECTS ON BABOON BLOOD CHEMISTRY
ASHA R. SHAHED (Operational Technologies Corp., San Antonio, TX), JUDY BARBER (Krug Life Sciences, Inc., San Antonio, TX), and PAUL M. WERCHAN (USAF, Armstrong Lab., Brooks AFB, TX) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 7 July 1993 p. 631-635. refs
Copyright

The effect of high (up to +6 Gz) acceleration on the glycolytic metabolites, blood gases, and pH were investigated by measuring

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these parameters in baboon blood collected by inserting a catheter into a jugular vein and remotely collecting blood before, during, and after high +Gz exposure on the Armstrong Laboratory centrifuge. The results disclosed a consistent pattern in the levels of glucose and lactate, both of which tended to decrease during the run, followed by increase after deceleration. It is speculated that, at high +Gz, G-induced loss of consciousness may occur as a protective response to reduce the brain metabolic rate, to maintain energy levels and to prevent severe cellular acidosis.
AIAA

A93-49294* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
EFFECT OF HINDLIMB UNWEIGHTING ON SINGLE SOLEUS FIBER MAXIMAL SHORTENING VELOCITY AND ATPASE ACTIVITY
K. S. MCDONALD and R. H. FITTS (Marquette Univ., Milwaukee, WI) Journal of Applied Physiology (ISSN 8750-7587) vol. 74, no. 6 June 1993 p. 2949-2957. Research supported by Marquette Univ. refs
(Contract NAG2-212)
Copyright

The effect of hindlimb unweighting (HU) for 1 to 3 wks on the shortening velocity of a soleus fiber, its ATPase content, and the relative contents of the slow and fast myosin was investigated by measuring fiber force, V(0), ATPase activity, and myosin content in SDS protein profiles of a single rat soleus fiber suspended between a motor arm and a transducer. It was found that HU induces a progressive increase in fiber V(0) that is likely caused, at least in part, by an increase in the fiber's myofibrillar ATPase activity. The HU-induced increases in V(0) and ATPase were associated with the presence of a greater percentage of fast type IIa fibers. However, a large population of fibers after 1, 2, and 3 wks of HU showed increases in V(0) and ATPase but displayed the same myosin protein profile on SDS gels as control fibers.
AIAA

A93-49555
THE INFLUENCE OF MILITARY LOW-ALTITUDE FLIGHT NOISE ON THE INNER EAR OF THE GUINEA PIG. I - HEARING THRESHOLD MEASUREMENTS
W. GEHRIG, P. MEYER, H. ISING, K. D. KUHL, R. SCHMIDT, and W. GRUTZMACHER Verein fuer Wasser-, Boden- und Lufthygiene, Schriftenreihe (ISSN 0300-8665) vol. 88 1993 p. 368-378.
Copyright

The auditory thresholds of about 60 anaesthetized guinea pigs were determined at three or four frequencies between 2 and 20 kHz, using the acoustically evoked brain stem potentials. The animals were then exposed to electro-acoustically reproduced MLAF noise with peak levels between 120 and 130 dB(A). The exposure occurred either once, or four times within three or 60 minutes. The level of noise increased at 7.5 and 75 dB/s (slow and fast increase). TTS was then determined. PTS was measured one week later. In over half the animals, exposure to rapidly increasing noise level with a peak of 126 dB(A) induced PTS of 30 dB or greater for at least one frequency. Exposure to a slowly increasing noise level with the same peak provoked significantly smaller PTS. Four exposures to a rapidly rising noise level within three minutes induced significantly smaller PTS than the same dosage within 60 minutes. Only in the latter case was PTS greater than TTS.
Author (revised)

A93-49556
THE INFLUENCE OF MILITARY LOW-ALTITUDE FLIGHT NOISE ON THE INNER EAR OF THE GUINEA PIG. II - SCANNING ELECTRON MICROGRAPHS
K. ISHI, H. ISING, H. J. MERKER, R. STENZEL, and M. WENZEL Verein fuer Wasser-, Boden- und Lufthygiene, Schriftenreihe (ISSN 0300-8665) vol. 88 1993 p. 379-387.
Copyright

Guinea pigs were exposed once to military low-altitude flight (MLAF) noise of 126 dB(A), and 12 cochleae were prepared for SEM 2-3 weeks after exposure. Qualitative analysis of the cilia of the outer hair cells revealed the types of damage already described in literature. The spatial distribution of cilia damage, however, differed essentially from the well known pattern: the damage was more or less pancochlear, beginning in the basal turn and increasing in frequency and severeness of damage till the end of the third turn. The most severe damage was visible in the outer row of the outer hair cells. This special pattern of cilia damage indicates that MLAF noise causes a different type of damage than the types described in literature.
Author (revised)

A93-49561
IMMUNOCYTOCHEMICAL LOCALIZATION OF ATRIAL NATRIURETIC FACTOR (ANF)-LIKE PEPTIDES IN THE BRAIN AND HEART OF THE TREEFROG HYLA JAPONICA - EFFECT OF WEIGHTLESSNESS ON THE DISTRIBUTION OF IMMUNOREACTIVE NEURONS AND CARDIOCYTES
M. FEUILLOLEY, L. YON, K. KAWAMURA, S. KIKUYAMA, J. GUTKOWSKA, and H. VAUDRY (Rouen Univ., Mont-Saint-Aignan, France) Journal of Comparative Neurology (ISSN 0021-9967) vol. 330, no. 1 April 1, 1993 p. 32-47.
Copyright

The localization of ANF-like immunoreactivity was investigated in the brain and heart of the treefrog Hyla japonica by the indirect immunofluorescence technique. Concurrently, the effect of weightlessness on the distribution of ANF-containing neurons and cardiocytes was studied in frogs that were sent into space for 9 days on the space station MIR. In control animals, the amygdala contained the most prominent group of ANF-immunoreactive cells and fibers. In 'space frogs', the intensity of labeling of the amygdala and nucleus olfactorius was similar to that seen in control animals. In contrast, the pallium and the striatum of 'space frogs' were totally devoid of positive cell bodies. In 'space frogs', the nucleus posterocentralis thalami and the nucleus posterolateralis thalami exhibited large ANF-immunoreactive perikarya, while in control frogs, these nuclei only contained scarce positive nerve fibers. In the heart, atrial cardiocytes exhibited intense ANF-like immunoreactivity. ANF-positive myocytes were also detected in the subpericardial region of the ventricle. The density and distribution of the staining were identical in the heart of control and 'space frogs'. These data support the concept that prolonged exposure to microgravity affects biosynthesis and/or release of ANF-related peptides in discrete regions of the amphibian brain.
Author (revised)

A93-49570* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
MICROWAVE DIGESTION PREPARATION AND ICP DETERMINATION OF BORON IN HUMAN PLASMA
A. A. FERRANDO, N. R. GREEN, K. W. BARNES, and B. WOODWARD (NASA, Johnson Space Center, Houston, TX) Biological Trace Element Research (ISSN 0163-4984) vol. 37, no. 1 April 1993 p. 17-25.
Copyright

A microwave digestion procedure, followed by Inductively Coupled Argon Plasma Spectroscopy, is described for the determination of boron (B) in human plasma. The National Institute of Standards and Technology (NIST) currently does not certify the concentration of B in any substance. The NIST citrus leaves 1572 (CL) Standard Reference Material (SRM) and wheat flour 1567a (WF) were chosen to determine the efficacy of digestion. CL and WF values compare favorably to those obtained from an open-vessel, wet digestion followed by ICP, and by neutron activation and mass spectrometric measurements. Plasma samples were oxidized by doubled-distilled ultrapure HNO3 in 120 mL PFA Teflon vessels. An MDS-81D microwave digestion procedure allows for rapid and relatively precise determination of B in human plasma, while limiting handling hazards and sources of contamination.

A93-49575
FUNCTIONAL ADAPTATION OF DIFFERENT RAT SKELETAL MUSCLES TO WEIGHTLESSNESS
L. STEVENS, Y. MOUNIER, and X. HOLY (Lille I, Univ.,

Villeneuve-d'Ascq, France) American Journal of Physiology (ISSN 0002-9513) vol. 264, no. 4 April 1993 p. R770-R776.
Copyright

The adaptation to weightlessness of two postural muscles, the slow soleus (SOL) and the fast gastrocnemius lateralis (GL), and a fast muscle used in movements, the extensor digitorum longus (EDL), was studied on five adult Wistar rats. The animals exposed to 14-day spaceflight aboard COSMOS 2044, were compared with synchronous (S) animals. The experiments were performed on single skinned fibers whose functional properties were studied. After weightlessness, the SOL exhibited two populations of fibers according to their Sr2(+) affinities: 40 percent remained slow (Fs) and 60 percent acquired fast-type properties (Ff). Both S and F GL and EDL showed a single distributed population of fast fibers. SOL fibers atrophied insofar as they showed a significant reduction in fiber diameter and absolute maximal tension Po (mg) but not in Po expressed in kg/sq cm. GL fibers showed no change in fiber diameter but a decrease in Po in mg and kg/sq cm. EDL fibers were not atrophied by weightlessness. Collectively, the data suggested that the adaptive changes subsequent to weightlessness were more dependent on the muscle function than on the fiber type, since both postural SOL and GL were modified. Author (revised)

A93-51025
ROLE OF THE CENTRAL NERVOUS SYSTEM IN THE CONTROL OF HYBERNATION [ROL' TSENTRAL'NOJ NERVNOJ SISTEMY V KONTROLE ZIMNEJ SPYACHKI]
A. V. BELOUSOV (RAN, Inst. Biofiziki Kletki, Pushchino, Russia) Uspekhi Fiziologicheskikh Nauk (ISSN 0301-1798) vol. 24, no. 2 Apr.-June 1993 p. 109-127. In RUSSIAN refs
Copyright

The role of the central nervous system in the control of hybernation is examined using data from the literature and results from experiments in which comparisons were made between neuronal activity from different brain structures of hybernating and alert mammals. It is shown that the major role in the control of hybernation belongs to the septal region, hypocampus, and hypothalamus. On the basis of the increased sensitivity of the septum neurones in hybernating animals, the importance of the medial septum region as the generator of the theta rhythm, and findings on metabolic and hormonal changes in hybernating animals, it is concluded that the medial complex of the septum nuclea is the 'guard station' of the forebrain during hybernation. The role of the thyrotropin-releasing hormone in regulating the cycle between the states of hybernation and alertness is discussed. AIAA

A93-51101
CHANGES IN THE INTENSITY OF FREE-RADICAL REACTIONS IN THE ORGANS OF RATS UNDER HYPOKINETIC STRESS, PROTECTED BY THE DELTA-SLEEP-INDUCING PEPTIDE AND ITS TYROSINE-CONTAINING ANALOGUE [IZMENENIYA INTENSIVNOSTI SVOBODNORADIKAL'NYKH REAKTSIJ V ORGANAKH KRYS PRI GIPOKINETICHESKOM STRESSE I ZASHCHITE DEL'TA-SON-INDUTSIRUYUSHCHIM PEPTIDOM I EGO TIROZINSODERZHASHCHIM ANALOGOM]
G. T. RIKHIREVA, M. G. MAKLETSOVA, A. M. MENDZHERITSKIJ, L. S. VARTANYAN, S. M. GUREVICH, E. L. LOZOVSKAYA, S. A. KOPYLOVSKIJ, A. V. RYLOVA, I. A. PRUDCHENKO, and I. I. MIKHALEVA (RAN, Inst. Khimicheskoj Fiziki and Inst. Bioorganicheskoj Khimii, Moscow; Rostovskij Gosudarstvennyj Univ., Rostov-on-Don, Russia) Rossijskaya Akademiya Nauk, Izvestiya, Seriya Biologicheskaya (ISSN 0002-3329) no. 2 Mar.-Apr. 1993 p. 243-256. In RUSSIAN refs
Copyright

The effects of two antistressor compounds, the delta-sleep-inducing peptide (DSIP) (Monnier et al., 1977) and its tyrosine-containing analogue ID-2, on the dynamics of changes in the contents of free radicals and malonic dialdehyde in the hypothalamus, the activity of liver superoxide dismutase, and the rate of mitochondrial oxidation were investigated in experiments on rats placed in restrictive cages. It was found that a single injection of DSIP or ID-2 given prior to hypokinesia decreased the rate of oxidation in the tissues of stressed animals, suggesting that the antioxidative effect of DSIP and ID-2 is responsible for the antistressor activity of these peptides. AIAA

A93-52408
PLANETARY QUARANTINE IN THE SOLAR SYSTEM - SURVIVAL RATES OF SOME TERRESTRIAL ORGANISMS UNDER SIMULATED SPACE CONDITIONS BY PROTON IRRADIATION
J. KOIKE and T. OSHIMA (Tokyo Inst. of Technology, Yokohama, Japan) Acta Astronautica (ISSN 0094-5765) vol. 29, no. 8 Aug. 1993 p. 629-632. IAF, International Astronautical Congress, 42nd, Montreal, Canada, Oct. 5-11, 1991, IAF Paper 91-542. Previously cited in issue 05, p. 759, Accession no. A92-18542 Research supported by MOESC refs
Copyright

A93-52618
INTERMITTENT COLD EXPOSURE CAUSES A MUSCLE-SPECIFIC SHIFT IN THE FIBER TYPE COMPOSITION IN RATS
T. J. WALTERS and S. H. CONSTABLE (Systems Research Labs., Inc.; USAF, Armstrong Lab., Brooks AFB, TX) Journal of Applied Physiology (ISSN 8750-7587) vol. 75, no. 1 July 1993 p. 264-267. refs
Copyright

An examination is conducted of the effects of long-term intermittent cold exposure on the fiber type composition of the type I soleus and the type IIa extensor digitorum longus (EDL) muscles of rats. While cold exposure had no significant effect on the fiber type composition of the EDL muscle, the soleus muscle experienced an enhancement of type IIa fibers of 156 percent; type I fibers decreased 24 percent. These results demonstrate that cold exposure of this type induces a type I-to-type IIa transformation in the soleus muscle, while having no influence on the EDL muscle. AIAA

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AEROSPACE MEDICINE

Includes physiological factors; biological effects of radiation; and effects of weightlessness on man and animals.

A93-49177
IMAGE TECHNOLOGY AND INFORMATION ANALYSIS OF BONE CHANGE WITH GRAVITATIONAL EXPOSURE
KOUSUKE NISHIMURA (Kanagawa Dental College, Yokosuka, Japan) Japanese Journal of Aerospace and Environmental Medicine (ISSN 0387-0723) vol. 30, no. 1 March 1993 p. 1-10. refs

The influences of gravitational changes on bone were analyzed from the point of view of imaging technology using a microfocus tube and a highly sensitive X-ray image sensor with the photostimulable phosphor. Gravitational changes markedly affected the spongy bone of the posterior vertebral joint, with bone resorption occurring at about 0 G and enhancement of bone formation at 2 G. Such changes were larger in the posterior vertebral joints that bear more weight. In the seventh posterior vertebral joint, which showed the largest bone changes, the photostimulated luminescence level increased by about 19 percent and decreased by about 46 at about 0 G and 2 G, respectively, compared with 1 G. These bone changes resemble those occurring during the aging process of mandibular bone trabeculae on earth. Author (revised)

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A93-49178
ARTERIAL OXYGEN SATURATION DURING +GZ ACCELERATION BY SHORT-RADIUS CENTRIFUGE
KENICHI IWASAKI, HAJIME SUZUKI (Nihon Univ. Hospital, Tokyo, Japan), MASAO ITO, TAKAICHI MANO, CHIKAKO SAEKI, and KAZUYOSHI YAJIMA (Nihon Univ., Tokyo, Japan) Japanese Journal of Aerospace and Environmental Medicine (ISSN 0387-0723) vol. 30, no. 1 March 1993 p. 11-17. In JAPANESE refs

Artificial gravity has been proposed to prevent the problems of physiological deconditioning in space. From ground-based studies to make an artificial gravity with a short radius centrifuge, it was reported that decreases of the arterial oxygen saturation (SaO2) caused by a ventilation/perfusion mismatch in the human lung and a decrease in central blood volume were observed at +3Gz or above it. However the duration of centrifuge was only a few minutes. We measured SaO2 during 60 min +Gz acceleration by a pulse oximeter. Seven men were studied at 1.4 G, 1.7 G, and 2.0 G. Significant decreases of SaO2 occurred at 1.7 G from 10 min to 30 min and at 2.0 G from 10 min to 40 min. SaO2 were improved after 35 min (1.7 G) and 45 min (2.0 G). Increase in heart rate, blood pressure, and tidal volume improved the decreases of SaO2 during +Gz acceleration. Author (revised)

A93-49180
EFFECT OF FOOD INTAKE ON SKIN VASOMOTOR RESPONSES TO HEAD-UP TILT IN HUMANS
ATSUO HIRAI, YOSHIE UKETA (Kanazawa Women's Junior College, Sue, Japan), MINORU TANABE, and SOHTARO SAKURADA (Kanazawa Univ., Takara, Japan) Japanese Journal of Aerospace and Environmental Medicine (ISSN 0387-0723) vol. 30, no. 1 March 1993 p. 27-29. refs

Cardiovascular responses to a 10-min head-up tilt at 60 deg were investigated in seven subjects before and after meal ingestion. The tilt increased heart rate and body core temperature and decreased blood pressure, mean skin temperature, and finger blood flow regardless of feeding conditions. However, finger temperature at the end of the tilt was significantly higher after food ingestion than before, which was not the case in other sites of the skin. Furthermore, the amount of reduction in finger blood flow was significantly reduced by food ingestion. These results suggest that vasoconstrictor drive to skin vessels is suppressed by food ingestion only in the fingers. Author (revised)

A93-49220
HEMODYNAMIC AND HORMONAL CORRELATES WITH EXPOSURE TO LOWER BODY NEGATIVE PRESSURE AFTER 12 HOURS HEAD-DOWN TILT
CHIHARU SEKIGUCHI, SEI YUMIKURA, TADASHI MURAI (NASDA, Tokyo, Japan), AKIRA MIYAMOTO, and KAZUYOSHI YAJIMA (Nihon Univ., Tokyo, Japan) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 7 July 1993 p. 599-605. refs
Copyright

Hemodynamic and hormonal responses to lower body negative pressure (LBNP) after 12-h head-down tilt (HDT) were examined to investigate the mechanism of orthostatic intolerance following spaceflight. Ten young healthy male volunteers participated in the experiment. After 6 deg HDT for 12 h, the tolerance to 1 h continuous -30 mm Hg LBNP was tested. Variables were measured before and after HDT, during LBNP, and 1 and 10 rain after LBNP. Significant reduction in leg volume and plasma volume were observed at the end of 12-h HDT. In the tolerant group, stroke volume index (SI) was decreased by 35 percent after 15 rain LBNP, and carotid arterial blood flow (CBF), by 27 percent at the end of LBNP compared to the pre-LBNP value. Of the 10 subjects, five developed presyncope during LBNP; they exhibited remarkable reduction in SI, CBF, and heart rate, and increased secretion of ADH and adrenaline during or just prior to presyncope. This nontolerant group tended to be hemoconcentrated from the start of the experiment. However, it will require a prospective study to determine if this variable is a reliable predictor of the outcome of the post-HDT LBNP test from data collected at the end of HDT. Author (revised)

A93-49221
HORMONAL RESPONSES DURING ORTHOSTASIS FOLLOWING 4 HOURS OF HEAD-DOWN TILT
JON W. WILLIAMSON, CRAIG G. CRANDALL, XIANGRONG SHI, WILLIAM G. SQUIRES, and PETER B. RAVEN (Texas College of Osteopathic Medicine, Fort Worth; Texas Lutheran College, Seguin) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 7 July 1993 p. 606-611. refs
(Contract F33615-87-D-0609; NIH-T32-HL-07625; NIH-HL-07625)
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The hypothesis that endurance exercise trained (ET) subjects would demonstrate a greater reduction in orthostatic tolerance as compared to untrained (UT) subjects following prior exposure to -6 deg head-down tilt (HDT), because of the decrease of vasoactive hormone and enzyme responses following HDT predisposing ET subjects to orthostatic intolerance, was tested. To this end, the neuroendocrine responses to head-up tilt (HUT) in groups of ET and UT subjects before and after 4-h of HDT were compared. The most marked difference between ET and UT subjects during HUT after prior exposure to HDT was a significant increase in arginine vasopressin (AVP) observed in UT (but not in ET subjects) at the onset of HUT, suggesting that AVP plays a primary role in the orthostatic responses to HUT following HDT. AIAA

A93-49222* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
CHANGES IN THE DARK FOCUS OF ACCOMMODATION ASSOCIATED WITH SIMULATOR SICKNESS
JENNIFER E. FOWLKES (Engineering and Economics Research, Inc., Orlando, FL), ROBERT S. KENNEDY (Essex Corp., Orlando, FL), LAWRENCE J. HETTINGER (Logicon Technical Services, Inc., Dayton, OH), and DEBORAH L. HARM (NASA, Johnson Space Center, Houston, TX) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 7 July 1993 p. 612-618. Research supported by Martin Marietta Energy Systems, Inc. refs
(Contract NAS9-17745)
Copyright

The relationship between the dark focus of accommodation and simulator sickness, a form of motion sickness, was examined in three experiments. In Experiment 1, dark focus was measured in 18 college students in a laboratory setting before and after they viewed a projected motion scene depicting low altitude helicopter flight. In Experiments 2 and 3, dark focus was measured in pilots (N = 16 and 23, respectively) before and after they 'flew' in moving-base helicopter flight simulators with optical infinity CRT visual systems. The results showed that individuals who experienced simulator sickness had either an inward (myopic) change in dark focus (Experiments 1 and 3) or attenuated outward shifts in dark focus (Experiment 2) relative to participants who did not get sick. These results are consonant with the hypothesis that parasympathetic activity, which may be associated with simulator sickness, should result in changes in dark focus that are in a myopic direction. Night vision goggles, virtual environments, extended periods in microgravity, and heads-up displays all produce related visual symptomatology. Changes in dark focus may occur in these conditions, as well, and should be measured.

A93-49225
PERCEPTUAL SCALING OF WHOLE-BODY LOW FREQUENCY LINEAR OSCILLATORY MOTION
J. F. GOLDING and A. J. BENSON (RAF, Inst. of Aviation Medicine, Farnborough, United Kingdom) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 7 July 1993 p. 636-640. refs
Copyright

Evidence that Z-axis oscillation in the Earth-vertical plane is more provocative of motion sickness than the equivalent imposed oscillation acting in the Earth-horizontal raises the possibility that horizontal oscillation is perceived as less intense than equivalent

vertical oscillation. In Experiment 1, subjects (n = 8) were oscillated through their head Z-axis in both the Earth-vertical and horizontal planes. In Experiment 2, another group (n = 10) were oscillated through their head Y-axis in the Earth-horizontal. Stimuli were five cycles of motion at 0.3 Hz ranging in 3.5 dB intervals from 0.19 to 2.15 m/sq s (Expt. 1) and from 0.1 to 3.98 m/sq s (Expt. 2). Perceptual scaling of intensity against acceleration was similar irrespective of direction of oscillation in the Earth-plane or head-body axis. Displacement tended to be overestimated, this being most marked for the lower acceleration levels in the horizontal condition. Results supported the notion that Stevens' Power Law exponents decrease as a function of increasing stimulus range. Differences in perception of oscillation intensity and displacement do not seem to explain the markedly greater nauseogenic potential of vertical oscillation. Author (revised)

A93-49226* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
FLIGHT CREW SLEEP DURING MULTIPLE LAYOVER POLAR FLIGHTS
MITSUO SASAKI, YUKO S. KUROSAKI (Japan Airlines, Flight Crew Medical Service Dept., Tokyo), CHERYL L. SPINWEBER (California Univ., La Jolla), R. C. GRAEBER (NASA, Ames Research Center, Moffett Field, CA), and TOSHIHARU TAKAHASHI (Japan Airlines, Flight Crew Medical Service Dept., Tokyo) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 7 July 1993 p. 641-647. refs
Copyright

This study investigated changes in sleep after multiple transmeridian flights. The subjects were 12 B747 airline pilots operating on the following polar flight: Tokyo (TYO)-Anchorage (ANC)-London (LON)-Anchorage-Tokyo. Sleep polysmonograms were recorded on two baseline nights (B1, B2), during layovers, and, after returning to Tokyo, two recovery nights were recorded (R1, R2). In ANC (outbound), total sleep time was reduced and, sleep efficiency was low (72.0 percent). In London, time in bed increased slightly, but sleep efficiency was still reduced. On return to ANC (inbound), there was considerable slow wave sleep rebound and multiple awakenings reduced sleep efficiency to 76.8 percent. Sleep efficiency on R2 was significantly lower than on B1 but not different from R1. To sum up, sleep of aircrews flying multiple transmeridian flights is disrupted during layovers and this effect persists during the two recovery nights. As a result, there is a marked cumulative sleep loss during multilegs polar route trip in comparison to single leg flights. These findings suggest that following such extensive transmeridian trips, crews should have at least three nights of recovery sleep in their home time zone before returning to duty. Author (revised)

A93-49227
DETERMINANTS OF +GZ-RELATED NECK PAIN - A PRELIMINARY SURVEY
OLAVI HAMALAINEN (Air Force Academy, Kauhava, Finland), HEIKKI VANHARANTA (Oulu Univ. Central Hospital, Finland), and RISTO BLOIGU (Oulu Univ., Finland) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 7 July 1993 p. 651, 652. Research supported by Finnish Defence Forces and Supporting Foundation of the Finnish Air Force refs
Copyright

The aim of the present study was to detect determinants of acute inflight neck pain in a cohort of 27 student fighter pilots frequently exposed to high +Gz forces. Strenuousness of work, job satisfaction, psychological distress, smoking habits, and frequency of muscle strength, muscle endurance, and aerobic training regimens were enquired about by questionnaire. Physical examination determined the subjects' height, body weight, body mass index, head and neck circumference, passive cervical range of motion, grip strength, and isometric strength of neck muscles. The frequency of muscle endurance training was the only possible determinant related to experienced acute inflight neck pain.

A93-49228
COCCIDIOIDOMYCOSIS - A PERSISTENT THREAT TO DEPLOYED POPULATIONS
W. L. RUSH, D. P. DOOLEY, S. P. BLATT, and D. M. DREHNER (USAF, Medical Center, Lackland AFB, TX) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 7 July 1993 p. 653-657. refs
Copyright

The world-wide deployability of aircrew members exposes them to a peculiar array of medical problems. Non-immune populations, upon deployment to endemic areas, may present to the deployed flight surgeon with acute, poorly recognizable syndromes, such as acute coccidioidomycosis. Alternatively, the acquisition of the chronic progressive form of coccidioidomycosis in endemic areas may be a problem for the flight surgeon, who may be faced with a poorly recognizable syndrome which first manifests itself weeks to months after the crewmember's return from deployment. We describe three cases of coccidioidomycosis in service members that highlight the difficulty in the diagnosis of this disease. These cases prompted an epidemiologic survey of recent cases of coccidioidomycosis among Air Force beneficiaries, presented here, to better define the impact of this disease on personnel assigned to endemic areas. A brief discussion of the epidemiologic and clinical features of the disease and of the aeromedical disposition of the aviator is presented.

A93-49291 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
INTRAMUSCULAR PRESSURE AND ELECTROMYOGRAPHY AS INDEXES OF FORCE DURING ISOKINETIC EXERCISE
M. ARATOW, R. E. BALLARD, A. G. GRENSHAW, J. STYF, D. E. WATENPAUGH, N. J. KAHAN, and A. R. HARGENS (NASA, Ames Research Center, Moffett Field, CA) Journal of Applied Physiology (ISSN 8750-7587) vol. 74, no. 6 June 1993 p. 2634-2640. refs
(Contract RTOP 199-14-12-04; RTOP 199-26-12-38)
Copyright

A direct method for measuring force production of specific muscles during dynamic exercise is presently unavailable. Previous studies indicate that both intramuscular pressure (IMP) and electromyography (EMG) correlate linearly with muscle contraction force during isometric exercise. The objective of this study was to compare IMP and EMG as linear assessors of muscle contraction force during dynamic exercise. IMP and surface EMG activity were recorded during concentric and eccentric isokinetic plantarflexion and dorsiflexion of the ankle joint from the tibialis anterior (TA) and soleus (SOL) muscles of nine male volunteers. Ankle torque was measured using a dynamometer, and IMP was measured via catheterization. IMP exhibited better linear correlation than EMG with ankle joint torque during concentric contractions of the SOL and the TA, as well as during eccentric contractions. IMP provides a better index of muscle contraction force than EMG during concentric and eccentric exercise through the entire range of torque. IMP reflects intrinsic mechanical properties of individual muscles, such as length-tension relationships, which EMG is unable to assess. Author (revised)

A93-49292 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
TRANSCAPILLARY FLUID RESPONSES TO LOWER BODY NEGATIVE PRESSURE
MICHAEL ARATOW (NASA, Ames Research Center, Moffett Field, CA), SUZANNE M. FORTNEY (NASA, Johnson Space Center, Houston, TX), DONALD E. WATENPAUGH, ALBERT G. CRENSHAW, and ALAN R. HARGENS (NASA, Ames Research Center, Moffett Field, CA) Journal of Applied Physiology (ISSN 8750-7587) vol. 74, no. 6 June 1993 p. 2763-2770. refs
(Contract RTOP 199-14-11-13; RTOP 199-14-12-04)
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The effect of lower body negative pressure (LBNP) on transcapillary fluid balance, with and without saline ingestion, was investigated in normally hydrated human subjects by measuring leg interstitial fluid pressure, leg circumference, plasma volume,

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and net whole body transcapillary fluid transport during and after supine LBNP in human subjects. The results indicate that prolonged LBNP, especially with saline ingestion, promotes fluid filtration into lower body tissues. AIAA

A93-49293
EFFECT OF WATER IMMERSION ON RENAL NATRIURETIC PEPTIDE (URODILATIN) EXCRETION IN HUMANS
PETER NORSK (Danish Aerospace Medical Centre of Research, Copenhagen, Denmark), CHRISTIAN DRUMMER (Muenchen, Univ., Medizinische Klinik, Munich, Germany), LARS B. JOHANSEN (Danish Aerospace Medical Centre of Research, Copenhagen, Denmark), and RUPERT GERZER (Muenchen, Univ., Medizinische Klinik, Munich, Germany) Journal of Applied Physiology (ISSN 8750-7587) vol. 74, no. 6 June 1993 p. 2881-2885. Research supported by Danish Space Board and DARA refs
Copyright

The effect of central hypervolemia induced by 12-h-long water immersion to the neck (WI) on the temporal profile of the renal urodilatin excretion was investigated using human subjects. Also examined were intraindividual correlations between renal urodilatin release, urinary fluid, and sodium excretion. It was found that, initially, WI induces an increase in the rate of renal urodilatin excretion (to a peak value at the third hour) followed by an attenuation toward preimmersion and control levels. The temporal profiles of the urinary fluid and sodium excretion values were similar to that of urodilatin excretion, except that the urinary fluid levels reached values close to control several hours before urodilatin excretion did, while the sodium excretion values were maintained above the control levels throughout the 12 h of WI. It is concluded that urodilatin might participate as one of several mechanisms of natriuresis and diuresis in humans. AIAA

A93-49295 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
CEREBRAL BLOOD FLOW VELOCITY IN HUMANS EXPOSED TO 24 H OF HEAD-DOWN TILT
Y. KAWAI, G. MURTHY, D. E. WATENPAUGH, G. A. BREIT, C. W. DEROSHIA, and A. R. HARGENS (NASA, Ames Research Center, Moffett Field, CA) Journal of Applied Physiology (ISSN 8750-7587) vol. 74, no. 6 June 1993 p. 3046-3051. Research supported by National Research Council refs
(Contract RTOP 199-14-12-04)
Copyright

This study investigates cerebral blood flow (CBF) velocity in humans before, during, and after 24 h of 6 deg head-down tilt (HDT), which is a currently accepted experimental model to simulate microgravity. CBF velocity was measured by use of the transcranial Doppler technique in the right middle cerebral artery of eight healthy male subjects. Mean CBF velocity increased from the pre-HDT upright seated baseline value of 55.5 +/- 3.7 (SE) cm/s to 61.5 +/- 3.3 cm/s at 0.5 h of HDT, reached a peak value of 63.2 +/- 4.1 cm/s at 3 h of HDT, and remained significantly above the pre-HDT baseline for over 6 h of HDT. During upright seated recovery, mean CBF velocity decreased to 87 percent of the pre-HDT baseline value. Mean CBF velocity correlated well with calculated intracranial arterial pressure (IAP). As analyzed by linear regression, mean CBF velocity = 29.6 + 0.32IAP. These results suggest that HDT increases CBF velocity by increasing IAP during several hours after the onset of microgravity. Importantly, the decrease in CBF velocity after HDT may be responsible, in part, for the increased risk of syncope observed in subjects after prolonged bed rest and also in astronauts returning to Earth.
Author (revised)

A93-49399
PROFILE ANALYSIS OF SIMULATOR SICKNESS SYMPTOMS - APPLICATION TO VIRTUAL ENVIRONMENT SYSTEMS
ROBERT S. KENNEDY, NORMAN E. LANE (Essex Corp., Orlando, FL), MICHAEL G. LILIENTHAL (U.S. Navy, Naval Air Systems Command, Washington), KEVIN S. BERBAUM (Iowa Univ., Iowa City), and LAWRENCE J. HETTINGER (Logicon Technical Services, Inc., Dayton, OH) Presence: Teleoperators and Virtual Environments (ISSN 1054-7460) vol. 1, no. 3 Summer 1992 p. 295-301. refs
Copyright

Flight simulators are examples of virtual environment systems that often give rise to a form of discomfort resembling classical motion sickness. The major difference between simulator sickness and other forms of motion sickness is that the former exhibits more oculomotor-related symptoms and far less actual vomiting. Based on data from a factor analysis of over 1000 Navy and Marine Corps pilot simulation exposures, a new scoring procedure for simulator sickness has recently been developed (Kennedy et al., 1992). The factor analytic scoring key provides subscales for oculomotor stress, nausea, and disorientation. Simulators are being examined in terms of these factor profiles to identify causes of simulator sickness. This paper describes the use of the multifactor scoring of the Simulator Sickness Questionnaire in diagnosing sources of simulator sickness in individual simulators. Reanalysis by this new methodology was employed to standardize existing simulator sickness survey data and to determine whether relationships existed that were missed by the more traditional scoring approaches. Author (revised)

A93-49400
MOTION SICKNESS AND OCULOMOTOR SYSTEMS IN VIRTUAL ENVIRONMENTS
SHELDON M. EBENHOLTZ (New York State Univ, NY) Presence: Teleoperators and Virtual Environments (ISSN 1054-7460) vol. 1, no. 3 Summer 1992 p. 302-305. refs
Copyright

The production of motion sickness, or asthenopia, by virtual environments (VEs), is of critical relevance to such systems' widespread acceptance; it is presently supposed that the problem stems not from the novel experience of VE as such, but from the visual and inertial stimuli that drive the eye movements themselves. Sustained exposure to interactive VEs is also projected to be capable of giving rise not only motion sickness, but also to adaptive shifts in one or more of the oculomotor systems. Induced ataxia has been recorded after adaptation of the vestibuloocular reflex. AIAA

A93-49401
VIRTUALLY INDUCED MOTION SICKNESS IN VIRTUAL ENVIRONMENTS
LAWRENCE J. HETTINGER (Logicon Technical Services, Inc., Dayton, OH) and GARY E. RICCIO (Illinois Univ., Urbana) Presence: Teleoperators and Virtual Environments (ISSN 1054-7460) vol. 1, no. 3 Summer 1992 p. 306-310. refs
Copyright

The syndrome of visually induced motion sickness (VIMS) occasionally arises when detectable lags are present between head movements and the recomputation and representation of helmet-mounted display scenes. The implementation of virtual reality technologies could be greatly affected by VIMS; an overview is accordingly presented of the current understanding of the relationship between visually specified self-motion and the absence of inertial displacements, on the one hand, and the onset of VIMS and similar perceptual-motor disturbances, on the other. AIAA

A93-49402
CYBERSICKNESS - PERCEPTION OF SELF-MOTION IN VIRTUAL ENVIRONMENTS
MICHAEL E. MCCAULEY and THOMAS J. SHARKEY (Monterey Technologies, Inc., Cary, NC) Presence: Teleoperators and Virtual Environments (ISSN 1054-7460) vol. 1, no. 3 Summer 1992 p. 311-318. refs
Copyright

Human perceptual systems have evolved to provide accurate information about orientation and movement through the environment. However, these systems have been challenged in the past century by modern transportation devices and will be further challenged by virtual environments (VEs) and teleoperator systems. Illusory self-motion within a VE ('cyberspace') will be entertaining and instructive, but for many users it will result in

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motion sickness ('cybersickness'). Sensory conflict theory and the poison hypothesis provide an unproven theoretical foundation for understanding the phenomenon. Although no single engineering solution is likely, the problem can be contained by a combination of engineering design, equipment calibration, and exposure management. Author (revised)

A93-49403* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
SPATIAL ORIENTATION, ADAPTATION, AND MOTION SICKNESS IN REAL AND VIRTUAL ENVIRONMENTS
PAUL DIZIO and JAMES R. LACKNER (Brandeis Univ., Waltham, MA) Presence: Teleoperators and Virtual Environments (ISSN 1054-7460) vol. 1, no. 3 Summer 1992 p. 319-328. refs (Contract NAG9-295)
Copyright

Reason and Brand (1975) noted that motion sickness occurs in many situations involving either passive body motion or active interaction with the world via indirect sensorimotor interfaces (e.g., prism spectacles). As might be expected, motion sickness is being reported in VEs that involve apparent self-motion through space, the best known examples being flight simulators (Kennedy et al., 1990). The goals of this paper are to introduce the motion-sickness symptomatology; to outline some concepts that are central to theories of motion sickness, spatial orientation, and adaptation; and to discuss the implications of some trends in VE research and development. Author (revised)

A93-49560
EFFECTS OF HIGH ALTITUDES ON FINGER COOLING TEST IN JAPANESE AND TIBETANS AT QINGHAI PLATEAU
M. TAKEOKA, Y. YANAGIDAIRA, A. SAKAI, K. ASANO, T. FUJIWARA, K. YANAGISAWA, O. KASHIMURA, G. UEDA, T. Y. WU, and Y. ZHANG (Shinshu Univ., Matsumoto, Japan) International Journal of Biometeorology (ISSN 0020-7128) vol. 37 Feb. 1993 p. 27-31.
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The influences of both hypobaric hypoxia and cold on peripheral circulation were studied using the finger cooling test (measurement of the decrease in finger temperature, measured at the dorsal surface of the finger, during immersion of the hand in 0 C water for 20 min) at the Qinghai Plateau. The same test was carried out at simulated altitudes in a 25 C climatic chamber to separate the hypobaric hypoxia influence from that of cold. In Japanese subjects at the Qinghai Plateau there was a significant difference between finger skin temperatures (FSTs) during 20 min of 0 C water immersion at altitudes of 2260 m and 4860 m. Mean finger skin temperature during the 20-min immersion measured at 4860 m was significantly lower than that at 2260 m. In Tibetan subjects, there was also a significant difference between FSTs at 2260 m and at 4860 m. In the 25 C climatic chamber, there was a significant difference between FSTs of Japanese expedition members at 2000 m and at 4000 m. In conclusion, the higher skin temperature in response to local cold immersion, which would have been caused by stronger hypobaric hypoxia, must have been masked by the lower ambient temperature. Author (revised)

A93-49562
ANALYSIS OF INJURIES FOLLOWING THE CRASH OF AVIANCA FLIGHT 52
S. A. DULCHAVSKY, E. R. GELLER, and D. A. IORIO (New York State Univ., Stony Brook) Journal of Trauma (ISSN 0022-5282) vol. 34, no. 2 Feb. 1993 p. 282-284.
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Analyses of injuries sustained in airline disasters have been hampered by the frequent association of burn injury and by poor documentation. An analysis of autopsy data from the crash of Avianca Flight 52 on Long Island, New York, where of 158 passengers, 73 died, shows that the majority of persons had multiple organ injuries (average, 3.8/victim). Severe neurologic trauma included subarachnoid hemorrhage (65 percent), skull fracture (32 percent), and lung contusion (33 percent). Orthopedic injuries (average, 4.4/victim) included pelvic (22 percent), tibial (37 percent), femur (22 percent), thoracic spine (33 percent), cervical spine (22 percent), and lumbar fractures (5 percent). Cardiovascular injuries included aortic transection (25 percent), heart laceration (14 percent), and major vascular injury (10 percent). Intraabdominal injuries included liver (10 percent), spleen (8 percent), and kidney (10 percent). Unrestrained infants suffered severe injuries. Deaths in this airline disaster were from severe head and upper body injuries. This report may allow reappraisal of current restraint and safety measures. Author (revised)

A93-49565
DOES DRINKING PROTECT AGAINST MOUNTAIN SICKNESS? [SCHUTZT TRINKEN VOR BERGKRANKHEIT?]
P. BARTSCH, S. SHAW, P. WEIDMANN, and O. OELZ (Heidelberg Univ., Medizinische Klinik und Poliklinik, Germany) Schweizerische Zeitschrift fuer Sportmedizin (ISSN 0036-7885) vol. 41, no. 1 March 1993 p. 7-13. In GERMAN
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This paper summarizes findings on fluid balance at high altitude. Of 57 mountaineers ascending from 1170 m to 4559 m within 22 to 77 hours, 24 developed acute mountain sickness (AMS) and 16 developed high altitude pulmonary edema (HAPE). In 14 cases HAPE was preceded by symptoms of AMS. Independently of the amount of fluid intake, which varied from 2 to 4 l/24 h in these studies, subjects daveloping AMS showed decreased diuresis and natriuresis compared to healthy controls with similar fluid intake. Higher fluid intake resulted in greater urine output but did not prevent AMS. Higher plasma levels of aldosterone at rest and greater exercise-induced rises of plasma aldosterone and vasopressine may explain the increased water and salt retention in subjects with AMS. Author (revised)

A93-49566
BACK ACHE IN HELICOPTER PILOTS [BOL U LEDIMA PILOTA HELIKOPTERA]
S. COLAK, S. JOVELIC, and J. MANOJLOVIC (Vazduhoplovnomedicinski Inst., Batajnica, Yugoslavia) Vojnosanitetski Pregled/Military Medical and Pharmaceutical Review (ISSN 0042-8450) vol. 49, no. 6 Nov.-Dec. 1992 p. 529-532. In SERBO-CROATIAN
Copyright

The present study of lower back pain (LBP) and harmful effects of flying sent questionnaires to 71 helicopter pilots of the experimental group, 22 flying helicopter mechanics, and a control group of 28 air-traffic controllers. The prevalence of LBP was highest in helicopter pilots, followed by helicopter mechanics and air-traffic controllers (respectively 53, 50, and 36 percent). Effects of exposure to vibration, body posture and working load have not contributed significantly to the occurrence of LBP. LBP has not led to an important difference in the strength of the back musculature, body mass index and spondylosis, that is, scoliosis. Author (revised)

A93-49567
REDUCTION OF POSTPRANDIAL LIPEMIA AFTER ACUTE EXPOSURE TO HIGH ALTITUDE HYPOXIA
J. FEREZOU, J. P. RICHLET, C. SEROUGNE, T. COSTE, E. WIRQUIN, and D. MATHE (Paris XI, Univ., Orsay, France) International Journal of Sports Medicine (ISSN 0172-4622) vol. 14, no. 2 Feb. 1993 p. 78-85.
Copyright

The effects of acute exposure to high altitude hypoxia upon plasma levels of lipids and lipoproteins were studied in 6 healthy subjects observed under strict dietary control. Fasting and postprandial values, first measured at low altitude (below 300 m), were compared to values measured 7 days after transfer by helicopter to the Observatoire Vallot (4350 m) near Mont-Blanc. Plasma levels of catecholamines and thyroid hormones were measured in parallel. Under normoxic conditions, a rise in plasma levels of cholesterol, triglycerides and phospholipids was found 4 hr after the test-meal, whereas circulating norepinephrine fell. Under hypoxic conditions, postprandial effects on lipid parameters disappeared, lipemic responses to the test-meal were dramatically

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reduced and plasma levels of norepinephrine increased. These effects were accompanied by a fall in triglyceride-rich lipoproteins, generally associated with a slight elevation of HDL-cholesterol, especially the less dense HDL2 fraction. Highly significant correlations were found between the magnitude of postprandial lipidemia and various lipid parameters, in particular HDL2-cholesterol which was negatively correlated. These observations strongly suggest that high altitude hypoxia, independent of interfering variables such as exercise training or cold exposure, induced a net stimulation of the lipolysis of plasma triglycerides. Author (revised)

A93-49568
EFFECTS OF SPACEFLIGHT ON THE MUSCULOSKELETAL SYSTEM - NIH AND NASA FUTURE DIRECTIONS
R. RABIN, S. L. GORDON, R. W. LYMN, P. W. TODD, M. A. FREY, and F. M. SULZMAN (Center for Space and Advanced Technology, Fairfax, VA) FASEB Journal (ISSN 0892-6638) vol. 7, no. 5 March 1993 p. 396-398.
Copyright

Prolonged bed rest, undertaken by volunteers or resulting from injury and disease, can impair bone and muscle function and structure; extended travel in space also induces these effects. Fluid shifts and disrupted fluid balance may also contribute to observed musculoskeletal aberrations in the weightless environment. Some molecular and cellular events involved in the loading and unloading of the musculoskeletal system are under neural and endocrine influence or control, whereas other events are influenced by local growth factors. Studies are in progress to develop interventions that preserve or improve musculoskeletal integrity in 1g. The NIAMS and NASA are interested in basic and clinical studies of the influence of microgravity on the musculoskeletal system. The interagency workshop results form the basis for new collaborative and cooperative research emphases for the biomedical community under a broad agreement between the National Institutes of Health and NASA.

A93-49569
RESPIRATORY CHANGES AND STRUCTURE OF SLEEP IN YOUNG HIGH-ALTITUDE DWELLERS IN THE ANDES OF PERU
J. H. COOTE, G. TSANG, A. BAKER, and B. STONE (Birmingnam Univ., United Kingdom) European Journal of Applied Physiology and Occupational Physiology (ISSN 0301-5548) vol. 66, no. 3 1993 p. 249-253.
Copyright

Sleep organization in eight young Peruvian high-altitude residents was studied in a laboratory in Cerro de Pasco at 4300 m. EEG, EMG, EOG, ECG, respiratory movements and arterial oxygen saturation were recorded and later analyzed in England. Haematocrits ranged from 48 to 64 percent. The amount of slow wave REM sleep was similar to that reported in young lowlanders sleeping at sea level but very different to the disturbed sleep in visitors sleeping at high altitude. All the Peruvians showed episodes of periodic breathing and respiratory apnoeas resulting in marked arterial oxygen desaturation. These events occurred either during stage 2 or REM sleep and were more frequent in those with lower haematocrits. The amount of wakefulness during the night was 2-3 times greater than would be expected in an age-matched lowland population at sea level. The awakenings were strongly associated with apnoeas but were negatively correlated with haematocrit, although this was only significant for seven of the subjects. Author (revised)

A93-49571
HEMODYNAMIC EFFECTS OF ALTITUDE EXPOSURE AND OXYGEN ADMINISTRATION IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE
B. W. BERG, T. A. DILLARD, S. S. DERDERIAN, and K. R. RAJAGOPAL (U.S. Army, Walter Reed Army Medical Center, Washington) American Journal of Medicine (ISSN 0002-9343) vol. 94, no. 4 April 1993 p. 407-412.
Copyright

Cardiovascular events are the leading cause of death during air travel. Because patients with chronic obstructive pulmonary disease (COPD) develop severe hypoxemia at altitude, we sought to determine whether changes in systemic hemodynamics may contribute to health risks during hypobaric hypoxia. We recorded radial artery catheter blood pressure, cardiac frequency, and cardiac ectopy in 18 men (aged 68 +/- 6 years) with severe COPD (forced expiratory volume in 1 second 0.97 L +/- 0.32 L) at sea level, after 45 minutes of steady-state hypobaric hypoxia at 2,438 m in a hypobaric chamber, and after oxygen supplementation at 2,438 m. Mean arterial pressure, systolic blood pressure (SBP), diastolic blood pressure, and pulsus paradoxus during acute hypobaric exposure did not differ from baseline. During oxygen supplementation, SBP declined ($p = 0.028$). Decreases in pulsus paradoxus and pulse pressure were noted on oxygen (p below 0.05). We found no changes in cardiac frequency. Vasopressor responses to hypoxia do not add to the risk of air travel in patients with severe COPD. Supplemental oxygen may cause beneficial hemodynamic changes in patients with COPD during acute hypobaric exposure. Author (revised)

A93-49572
EFFECT OF TRANSDERMALLY ADMINISTERED SCOPOLAMINE ON THE VESTIBULAR SYSTEM IN HUMANS
H. SHOJAKU, Y. WATANABE, M. ITO, K. MIZUKOSHI, K. YAJIMA, and C. SEKIGUCHI (Toyama Medical and Pharmaceutical Univ., Japan) Acta Oto-Laryngologica, Supplement (ISSN 0365-5237) vol. 504 1993 p. 41-45.
Copyright

In order to elucidate the effect of scopolamine on the vestibular system in humans, various experimentally-induced forms of nystagmus, i.e. caloric nystagmus, rotational nystagmus, optokinetic nystagmus, visual-vestibular interaction and optokinetic after nystagmus, were evaluated before and after the administration of two pieces of Scopoderm-TTS or placebo patches retro-auricularly. Scopolamine reduced the responses of both the caloric and optokinetic after nystagmus compared with the placebo. The possible action site of this drug is discussed.

A93-49573
SALIVARY TOTAL PROTEIN AND EXPERIMENTAL CORIOLIS SICKNESS
M. IGARASHI, M. F. RESCHKE, C. HENLEY, S. MACDONALD, R. KOHL, and K. MIZUKOSHI (Nihon Univ., Tokyo, Japan) Acta Oto-Laryngologica, Supplement (ISSN 0365-5237) vol. 504 1993 p. 38-40.
Copyright

Symptomatic reporting has been used in quantifying the severity of motion sickness including Coriolis sickness. This study was designed to objectively examine if the dynamic changes of salivary protein concentration relate to the severity of Coriolis sickness. Healthy adults with normal vestibular function underwent a modified Coriolis Sickness Susceptibility Index (CSSI) test, utilizing a staircase profile. Salivary samples were obtained prior to stimulation, 15, 30, and 45 rain following stimulus onset, and/or upon reaching 'nausea-II' endpoint. Total protein concentration tended to rise over the initial 30 min of stimulation, and then level off or decline. A statistically significant difference was found between the pre-stimulation and 30 min samples. Although some variability existed among the subjects, the general pattern of changes along the time course was similar. An inverse correlation approaching statistical significance was found between control (non-stimulus) total protein levels, and minutes of Coriolis stimulation required to reach the 'nausea-II' endpoint. Thus, baseline salivary total protein levels can be of use in predicting susceptibility of Coriolis sickness and other forms of motion sickness.

A93-49574
OPERATION EVEREST II - SPIROMETRIC AND RADIOGRAPHIC CHANGES IN ACCLIMATIZED HUMANS AT SIMULATED HIGH ALTITUDES
C. H. WELSH, P. D. WAGNER, J. T. REEVES, D. LYNCH, T. M.

CINK, J. ARMSTRONG, M. K. MALCONIAN, P. B. ROCK, and C. S. HOUSTON (Colorado Univ., Denver) American Review of Respiratory Disease (ISSN 0003-0805) vol. 147, no. 5 May 1993 p. 1239-1244.
Copyright

We report spirometry and radiographic data on eight normal male human subjects during prolonged graded altitude exposure to as high as 8848 m above sea level in a hypobaric chamber. We found a significant and progressive drop in FVC by 14 +/- 3 percent over 40 days, which resolved slowly during the first 48 h after descent. With altitude, midrange forced expiratory flow (FEF25-75) increased by 82 +/- 3 percent, probably because of reduced air density. FEV 1, however, did not change. Chest radiographs on subjects taken 2 h after descent to sea level showed a pattern of pulmonary artery enlargement and interstitial edema. These data suggest that increased pulmonary blood volume and edema may be causes of the restricted pulmonary function pattern. Author (revised)

A93-51116
IMMUNE AND PHYSIOLOGICAL MECHANISMS OF HYPOXIC REACTIONS [IMMUNOFIZIOLOGICHESKIE MEKHANIZMY DEJSTVIYA GIPOKSII]
V. S. NOVIKOV, V. V. GORANCHUK, V. S. SMIRNOV, and S. I. LUSTIN (Voenno-Meditsinskaya Akademiya, St. Petersburg, Russia) Fiziologiya Cheloveka (ISSN 0131-1646) vol. 19, no. 4 July-Aug. 1993 p. 104-113. In RUSSIAN refs
Copyright

Changes in the immune and physiologocal blood parameters of humans subjected to multiple exposures to moderate-level hypobaric hypoxia (15 daily exposures to 1500-m in pressure chamber, with two 2-day interruptions) were recorded in healthy subjects by measuring peripheral-blood indices on the 6th, 11th, and 15th day of exposure and 45 days later. It was found that hypobaric hypoxia stimulates erythropoiesis and activates mechanisms of specific and nonspecific defense in the organism. The 45-day period following the exposure to hypoxia is characterized by a drop in the intensity of erythropoiesis with simultaneous activation of lymphopoiesis and aerobic mechanisms of phagocytosis. AIAA

A93-51117
REGULATION OF THE CARBOHYDRATE METABOLISM IN HUMANS RESIDING IN THE NORTH [REGULYATSIYA UGLEVODNOGO OBMENA U CHELOVEKA NA SEVERE]
N. V. SHVAREVA and T. P. BARTOSH (RAN, Inst. Biologicheskikh Problem Severa, Magadan, Russia) Fiziologiya Cheloveka (ISSN 0131-1646) vol. 19, no. 4 July-Aug. 1993 p. 127-132. In RUSSIAN refs
Copyright

The relation between the duration of residence in the Russian Far North and the contents of blood glucose and the hormones involved in carbohydrate metabolism (insulin, C-peptide-insulin, cortisone, glucagon, and somatotropin releasing hormone, SRH) was investigated by determining these parameters in blood of Magadan (Russia) residents who were not ethnic natives. It was found that Magadan residents had lower concentrations of blood glucose than residents of other regions of Russia, but with no correlation between the duration of residence and blood glucose. The duration of residence, however, was found to correlate positively with the blood contents of insulin and C-peptide and negatively with the concentrations of cortisol, glucagon, and SRH. AIAA

A93-52297
INCIDENCE OF CARDIAC DYSRHYTHMIAS OCCURRING DURING CENTRIFUGE TRAINING
IAN MCKENZIE and KENT K. GULLINGHAM (USAF, Armstrong Lab., Brooks AFB, TX) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 8 Aug. 1993 p. 687-691. refs
Copyright

A study documenting the incidence of dysrhythmias in a large group of volunteers consisting of students attending professional aeromedical training courses at the USAF School of Aerospace Medicine is described. The subjects participated in high-G centrifuge training on the Armstrong Laboratory centrifuge, during which ECG monitoring was routinely performed. Data obtained from the records of 1,180 training sessions from 1984-91 were transcribed to a database on a PC. It is concluded that centrifuge training can provoke serious dysrhythmias in ostensibly healthy individuals, and ECG monitoring of an aircrew undergoing such training is recommended for their safety. AIAA

A93-52298
DEGENERATION OF CERVICAL INTERVERTEBRAL DISKS IN FIGHTER PILOTS FREQUENTLY EXPOSED TO HIGH +GZ FORCES
OLAVI HAMALAINEN (Air Force Academy, Kauhava, Finland), HEIKKI VANHARANTA (Oulu Univ. Central Hospital, Finland), and TIMO KUUSELA (Central Military Hospital, Helsinki, Finland) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 8 Aug. 1993 p. 692-696. Research supported by Finnish Defence Forces and Finnish Air Force refs
Copyright

This study investigated the occurrence and the degree of cervical disk degeneration among senior fighter pilots frequently exposed to high +Gz forces, compared with nonexposed controls matched for age and sex. A resistive magnetic resonance (MR) scanner operating at 0.1 T was used to image the cervical intervertebral disks. Sagittal MR images were obtained and disk degeneration was graded 0-6. Both the occurrence and the median degree of disk degeneration were greater among the pilots than among the controls. The greatest difference in the occurrence of disk degeneration (grades 1-6), which also reached statistical significance, was detected for the C3-4 disk: 88 percent among the fighter pilots and 64 percent among the controls, respectively. With respect to the moderate degenerative changes (grades 3 and 4) in the C3-4 disk, the difference in the occurrence (88 percent vs. 36 percent) was again statistically significant. There was no difference between the other disks. The median disk degeneration between the groups differed (2.0 vs. 1.0), the difference being the most remarkable (3.0 vs. 1.0) for the C3-4 disk. The differences in the median disk degeneration were also statistically significant. Author (revised)

A93-52299
THE TIME-COURSE OF ALCOHOL IMPAIRMENT OF GENERAL AVIATION PILOT PERFORMANCE IN A FRASCA 141 SIMULATOR
DANIEL MORROW (Decision Systems, Stanford, CA), JEROME YESAVAGE (Stanford Univ.; USVA, Medical Center, Palo Alto, CA), VON LEIRER (Decision Systems, Stanford, CA), NANCY DOLHERT (Stanford Univ., CA), JOY TAYLOR, and JARED TINKLENBERG (Stanford Univ.; USVA, Medical Center, Palo Alto, CA) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 8 Aug. 1993 p. 697-705. refs
(Contract NIH-AA-07035; NIH-1-R01-AG-08521-01)
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This study examined the time-course of alcohol impairment of general aviation pilot simulator performance. We tested 14 young (mean age 25.8) and 14 older (mean age 37.9) pilots in a Frasca 141 simulator during alcohol and placebo conditions. In the alcohol condition, pilots drank alcohol and were tested after reaching 0.10 percent BAL, and then 2, 4, 8, 24, and 48 h after they had stopped drinking. They were tested at the same times in the placebo condition. Alcohol impaired overall performance. Alcohol impairment also depended on the order in which subjects participated in the alcohol and placebo sessions, with larger decrements for the alcohol-placebo order than for the opposite order. To examine the influence of alcohol independent of session order effects, we compared performance in the first alcohol session with performance in the first placebo session. This analysis showed that alcohol significantly reduced mean performance in the alcohol condition at 0.10 percent BAL and at 2 h. In addition, alcohol increased variability in performance in the alcohol session from

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0.10 percent BAL to 8 h, suggesting that some subjects were more susceptible to alcohol than others. Older pilots tended to perform some radio communication tasks less accurately than younger pilots. Author (revised)

A93-52302
THE EFFECTS OF BENADRYL AND HISMANAL ON MOOD, PHYSIOLOGICAL MEASURES, ANTIHISTAMINE DETECTION, AND SUBJECTIVE SYMPTOMS

VALERIE J. RICE (Virginia Polytechnic Inst. and State Univ., Blacksburg; U.S. Army, Research Inst. of Environmental Medicine, Natick, MA) and HARRY L. SNYDER (Virginia Polytechnic Inst. and State Univ., Blacksburg) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 8 Aug. 1993 p. 717-725. refs
(Contract DAMD17-89-C-9073)
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The majority of antihistamines have sedative effects; however, it is claimed that Hismanal (astemizole) does not possess central nervous system side effects. A three-factor repeated measures double-blind design was used to compare the effects of single oral doses of Benadryl (diphenhydramine), 50 mg; Hismanal, 10 mg; and placebo on two mood scales, physiological measures, sleepiness, the ability to detect ingestion of an antihistamine versus placebo, and symptoms in 28 healthy men. Higher tension, greater fatigue, and lower activity levels were reported post-Benadryl. Lower vigor-activity and higher confusion-bewilderment post-Hismanal and post-Benadryl were noted 1 h postingestion, with confusion being lower and activity higher for Hismanal than for Benadryl. Low vigor-activity, high confusion, and increased sleepiness post-Benadryl persisted for 3 h, while fatigue-inertia persisted for 7 h. Results suggest that Hismanal is superior to Benadryl for avoidance of subjective effects; however, neither antihistamine was entirely devoid of subjective effects.
Author (revised)

A93-52303
THE EFFECTS OF BENADRYL AND HISMANAL ON PSYCHOMOTOR PERFORMANCE AND PERCEIVED PERFORMANCE

VALERIE J. RICE (Virginia Polytechnic Inst. and State Univ., Blacksburg; U.S. Army, Research Inst. of Environmental Medicine, Natick, MA) and HARRY L. SNYDER (Virginia Polytechnic Inst. and State Univ., Blacksburg) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 8 Aug. 1993 p. 726-734. refs
(Contract DAMD17-89-C-9073)
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Classic antihistamines (H1 antagonists) have sedative effects and can impair psychomotor performance. It is claimed that Hismanal (astemizole) does not possess central nervous system side effects. A three-factor, repeated measures, double-blind design was used to compare the effects of single oral doses of Benadryl (diphenhydramine), 50 mg; Hismanal, 10 mg; and placebo on a battery of 11 cognitive-information processing tasks and performance ratings in 28 healthy men. Performance decrements were seen at 1 h post-Benadryl ingestion on Following Directions, at 1.5 h on Unstable Tracking, and at 3 h on serial addition/subtraction. No decrements in performance were found post-Hismanal. Subjects perceived their performance as poorer following Benadryl ingestion versus placebo and Hismanal for 3 h postingestion. Results demonstrate performance effects post-Benadryl ingestion for 1 h longer than previously reported. Tasks which demonstrated sensitivity to antihistamines were those which required an element of sustained attention and those which required a visual-motor response. Author (revised)

A93-52304
PREDICTION OF MAXIMAL OXYGEN UPTAKE FROM SUBMAXIMAL EXERCISE TESTING IN AEROBICALLY FIT AND NONFIT MEN

G. H. HARTUNG (Univ. of Hawaii at Manoa, Honolulu), LARRY P. KROCK, CRAIG G. CRANDALL, ROGER U. BISSON, and LOREN G. MYHRE (USAF, Armstrong Lab., Brooks AFB, TX) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 8 Aug. 1993 p. 735-740. refs
Copyright

Aerobic physical fitness, as determined by the body's maximal capacity to utilize oxygen (max. O2 uptake) during demanding work, is an important determinant of a person's ability to perform many military tasks. The precent 2.4 km run has not proven itself capable of accurately estimating this important factor on a periodic basis. This paper reviews prior studies of heart rate response to known workloads on a cycle ergometer to estimate max. O2 uptake. This submaximal test, as revised by scientists at the USAF Armstrong Laboratory at Brooks AFB (Texas), was validated on 22 male subjects by comparing the test results with laboratory measurements of max. O2 uptake obtained by analysis of expired air during maximal treadmill exercise. Two groups of subjects were selected; one consisting of highly trained runners and the other of inactive subjects who did not perform regular aerobic exercise. The cycle ergometry prediction underestimated measured max. O2 uptake by 8.1 ml/kg per min in all subjects, but there was a correlation of 0.95 between the estimated and measured values. Both estimated and measured max O2 uptake values were significantly higher in the group of trained runners than in the inactive subjects. Author (revised)

A93-52305
RISK ASSESSMENT AND CLINICAL AEROMEDICAL DECISION-MAKING

JONATHAN B. CLARK (U.S. Marine Corps Air Station, Yuma, AZ; U.S. Navy, Naval Aerospace and Operational Medical Inst., Pensacola, FL) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 8 Aug. 1993 p. 741-747. refs
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This article presents a format of aeromedical decision-making used in neurology cases referred to a U.S. Navy Special Board of Flight Surgeons (SBFS) from 1988 to 1990. The format consists of a series of questions addressing aeromedical concerns, an aeromedical disposition flowchart, and a decision analysis tree. Decision Analysis is a tool used in clinical medicine to assist decision-making under conditions of uncertainty. The Decision Analysis approach may be applied to complex aeromedical disposition questions that face flight surgeons. The concept of risk assessment as it applies to decision-making and aeromedical disposition is discussed. The outcome of 24 neurology cases referred for aeromedical disposition are presented.

A93-52306
MORTALITY EXPERIENCE OF COCKPIT CREWMEMBERS FROM JAPAN AIRLINES

MASANOBU KAJI (Japan Airlines, Medical Services Div.; Jikei Univ., Tokyo, Japan), TOSHIRO TANGO (Japan Airlines, Medical Services Div.; Inst. of Public Health, Tokyo, Japan), ICHIRO ASUKATA, NAOKO TAJIMA, KANHACHIRO YAMAMOTO, YOSHIAKI YAMAMOTO, and MASAOMI HOKARI (Japan Airlines, Medical Services Div., Tokyo, Japan) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 8 Aug. 1993 p. 748-750. refs
Copyright

The purpose of this study was to evaluate the long-term mortality and causes of death among cockpit crewmembers. A total of 2327 cockpit crewmembers registered at Japan Airlines between August 1, 1952, and December 31, 1988, were traced to assess mortality. Medical records were also reviewed. The mortality rates for the cockpit crewmembers were compared to those for the general Japanese population using standardized mortality ratios. As of December 31, 1988, 59 (2.5 percent) of 2327 individuals were deceased, and the leading causes of death were accidents, malignant neoplasms, and cardiovascular diseases. The overall mortality rate for the cockpit crew was significantly lower than the national standard. However, marked differences were found in cause-specific mortality, where mortality due to accidents was significantly higher, deaths from cancer were similar, and those

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for cerebral vascular accidents and coronary artery disease were lower than comparable rates for the general population.
Author (revised)

A93-52307
ACUTE HYPERTENSIVE RESPONSE TO +GZ ACCELERATION IN MILDLY HYPERTENSIVE PILOTS
ARIE SHAMISS, SIMCHA MEISEL, and TALMA ROSENTHAL (Chaim Sheba Medical Centre; Tel Aviv Univ., Israel) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 8 Aug. 1993 p. 751-754. refs
Copyright

Two fighter pilots with mild hypertension and a mildly hypertensive response to exercise underwent ambulatory blood pressure monitoring during a routine flight that included a brief exposure to +4 Gz stress. They exhibited an acute elevation of both systolic and diastolic blood pressures during +4 Gz stress: from 140/90 and 135/90 mm Hg to 179/139 and 130/140 mm Hg, respectively. Heart rate reached 182 and 132 beats/min. These responses of hypertensives may reflect exaggerated baroreceptor and sympathetic responses which cause a pronounced overshoot of blood pressure. The findings demonstrate the value of 24-h ambulatory blood pressure monitoring for documenting episodic elevations of blood pressure that do not influence the 'normal' average blood pressure, but may nevertheless have important clinical implications. Author (revised)

A93-52401
MAIN MEDICAL RESULTS OF EXTENDED FLIGHTS ON SPACE STATION MIR IN 1986-1990
A. I. GRIGOR'EV, S. A. BUGROV, V. V. BOGOMOLOV, A. D. EGOROV, V. V. POLYAKOV, I. K. TARASOV, and E. B. SHUL'ZHENKO (Inst. of Biomedical Problems, Moscow, Russia) Acta Astronautica (ISSN 0094-5765) vol. 29, no. 8 Aug. 1993 p. 581-585. IAF, International Astronautical Congress, 42nd, Montreal, Canada, Oct. 5-11, 1991, IAF Paper 91-547. Previously cited in issue 05, p. 761, Accession no. A92-18545 refs
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A93-52402* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
COMPARISON OF TREATMENT STRATEGIES FOR SPACE MOTION SICKNESS
J. R. DAVIS, R. T. JENNINGS, and B. G. BECK (NASA, Johnson Space Center, Houston, TX) Acta Astronautica (ISSN 0094-5765) vol. 29, no. 8 Aug. 1993 p. 587-591. IAF, International Astronautical Congress, 42nd, Montreal, Canada, Oct. 5-11, 1991, IAF Paper 91-554. Previously cited in issue 05, p. 761, Accession no. A92-18551 refs
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A93-52403
PRE-ADAPTATION TO SHIFTWORK IN SPACE
A. SAMEL, H. M. WEGMANN, and M. VEJVODA (DLR, Inst. fuer Flugmedizin, Cologne, Germany) Acta Astronautica (ISSN 0094-5765) vol. 29, no. 8 Aug. 1993 p. 593-599. IAF, International Astronautical Congress, 42nd, Montreal, Canada, Oct. 5-11, 1991, IAF Paper 91-564. Previously cited in issue 05, p. 762, Accession no. A92-18558 refs
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A93-52404
EVALUATION OF SPONTANEOUS BAROREFLEX RESPONSE AFTER 28 DAYS HEAD DOWN TILT BEDREST
R. L. HUGHSON (Waterloo Univ., Canada; Lyon I, Univ., France), Y. YAMAMOTO, G. C. BUTLER (Waterloo Univ., Canada), A. GUELL (Inst. de Medecine et de Physiologie Spatiales, Toulouse, France), and C. GHARIB (Lyon I, Univ., France) Acta Astronautica (ISSN 0094-5765) vol. 29, no. 8 Aug. 1993 p. 601-605. IAF, International Astronautical Congress, 42nd, Montreal, Canada, Oct. 5-11, 1991, IAF Paper 91-550. Previously cited in issue 05, p. 761, Accession no. A92-18547 Research supported by CNES, DRET, NSERC, et al refs
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A93-52405
DYNAMIC ANALYSIS OF OCULAR TORSION IN PARABOLIC FLIGHT USING VIDEO-OCULOGRAPHY
W. TEIWES, A. H. CLARKE, and H. SCHERER (Berlin, Freie Univ., Germany) Acta Astronautica (ISSN 0094-5765) vol. 29, no. 8 Aug. 1993 p. 607-611. IAF, International Astronautical Congress, 42nd, Montreal, Canada, Oct. 5-11, 1991, IAF Paper 91-553. Previously cited in issue 05, p. 761, Accession no. A92-18550 Research supported by DARA refs
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A93-52407
EFFECTS OF UNILATERAL SELECTIVE HYPERGRAVITY STIMULATION ON GAIT
M. LAZERGES and P. BESSOU (Toulouse III, Univ., France) Acta Astronautica (ISSN 0094-5765) vol. 29, no. 8 Aug. 1993 p. 621-628. IAF, International Astronautical Congress, 42nd, Montreal, Canada, Oct. 5-11, 1991, IAF Paper 91-556. Previously cited in issue 05, p. 762, Accession no. A92-18553 Research supported by CNES, Matra, Fondation pour la Recherche Medicale Francaise, and Toulouse-Rangueil Hospital refs
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A93-52409* National Aeronautics and Space Administration, Washington, DC.
MEDICAL CONCERNS FOR EXPLORATION-CLASS MISSIONS
DONALD F. STEWART (NASA, Aerospace Medicine Office, Washington) and BARBARA F. LUJAN (NASA, Life Sciences Div., Washington) Acta Astronautica (ISSN 0094-5765) vol. 29, no. 8 Aug. 1993 p. 633-638. IAF, International Astronautical Congress, 42nd, Montreal, Canada, Oct. 5-11, 1991, IAF Paper 91-546. Previously cited in issue 05, p. 761, Accession no. A92-18544 refs
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A93-52505
COGNITIVE FUNCTION AT HIGH ALTITUDE
ARTHUR F. KRAMER (Illinois Univ., Urbana), JOHN T. COYNE (U.S. Navy, Naval Health Research Center, San Diego, CA), and DAVID L. STRAYER (Utah Univ., Salt Lake City) Human Factors (ISSN 0018-7208) vol. 35, no. 2 June 1993 p. 329-344. Research supported by U.S. Navy refs
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The effects of altitude on human performance and cognition were evaluated in a field study performed on Mount Denali in Alaska during the summer of 1990. Climbers performed a series of perceptual, cognitive, and sensory-motor tasks before, during, and after climbing the West Buttress route on Denali. Relative to a matched control group that performed the tasks at sea level, the climbers showed deficits of learning and retention in perceptual and memory tasks. Furthermore, climbers performed more slowly on most tasks than did the control group, suggesting long-term deficits that may be attributed to repeated forays to high altitudes.

A93-52617* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
PULMONARY DIFFUSING CAPACITY, CAPILLARY BLOOD VOLUME, AND CARDIAC OUTPUT DURING SUSTAINED MICROGRAVITY
G. K. PRISK, HAROLD J. B. GUY, ANN R. ELLIOTT, ROBERT A. DEUTSCHMAN, III, and JOHN B. WEST (California Univ., La Jolla) Journal of Applied Physiology (ISSN 8750-7587) vol. 75, no. 1 July 1993 p. 15-26. refs
(Contract NAS9-16037)
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We measured pulmonary diffusing capacity (DL), diffusing capacity per unit lung volume, pulmonary capillary blood volume (Vc), membrane diffusing capacity (Dm), pulmonary capillary blood flow or cardiac output (Qc), and cardiac stroke volume (SV) in

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four subjects exposed to nine days of microgravity. DL in microgravity was elevated compared with preflight standing values and was higher than preflight supine because of the elevation of both Vc and Dm. The elevation in Vc was comparable to that measured supine in 1 G, but the increase in Dm was in sharp contrast to the supine value. We postulate that, in 0 G, pulmonary capillary blood is evenly distributed throughout the lung, providing for uniform capillary filling, leading to an increase in the surface area available for diffusion. By contrast, in the supine 1-G state, the capillaries are less evenly filled, and although a similar increase in blood volume is observed, the corresponding increase in surface area does not occur. DL and its subdivisions showed no adaptive changes from the first measurement 24 h after the start of 0 G to eight days later. Similarly, there were no trends in the postflight data, suggesting that the principal mechanism of these changes was gravitational. The increase in Dm suggests that subclinical pulmonary edema did not result from exposure to 0 G. Qc was modestly increased inflight and decreased postflight compared with preflight standing. Compared with preflight standing, SV was increased 46 percent inflight and decreased 14 percent in the 1st week postflight. There were temporal changes in Qc and SV during 0 G, with the highest values recorded at the first measurement, 24 h into the flight. The lowest values of Qc and SV occurred on the day of return. Author (revised)

A93-52618
NOCTURNAL PITUITARY HORMONE AND RENIN PROFILES DURING CHRONIC HEAT EXPOSURE
J. SAINI, G. BRANDENBERGER, J. P. LIBERT, and M. FOLLENIUS (CNRS, Lab. de Physiologie et de Psychologie Environnementale; Inst. National de Recherche et de Securite, Strasbourg, France) Journal of Applied Physiolcgy (ISSN 8750-7587) vol. 75, no. 1 July 1993 p. 294-300. refs
(Contract DRET-87-219)
Copyright

To establish the principal endocrine systems involved in the initial adaptation to chronic passive heat exposure, responses of the hydromineral and pituitary systems were compared. Nocturnal plasma profiles of growth hormone, prolactin, thyrotropin, and plasma renin activity were determined during a period of prolonged heat exposure designed to simulate a hot climate. Two groups of six male subjects (G1 and G2) were kept for 11 days in a climatically controlled apartment. The G1 group was exposed to 20 C throughout the study, and the G2 group was exposed to 20 C for 5 days and to 35 C for the following six days. Blood was collected continuously during the 1st and 10th nights from 2300 to 0700 h and was sampled in 10-min aliquots for hormone analysis. Heat exposure increased the nocturnal mean core temperature and stimulated plasma renin activity but had little effect on the pituitary hormones except for a small increase in prolactin. For the G1 group there was no change in hormone profiles. These results demonstrate that the principal initial endocrine system involved in acclimatization to passive heat exposure is the renin-angiotensin system, reflecting counteractive measures against salt and water losses. In contrast, five days of continuous heat exposure does not provoke metabolic changes, indicated by the small effect on pituitary hormone profiles. Author (revised)

A93-52620
VOLUME-HOMEOSTATIC MECHANISMS IN HUMANS DURING A 12-H POSTURE CHANGE
PETER NORSK, CARSTEN STADEAGER, LARS B. JOHANSEN, JORGEN WARBERG, PETER BIE, NIELS FOLDAGER, and NIELS J. CHRISTENSEN (Danish Aerospace Medical Centre of Research; Rigshospitalet; Copenhagen Univ.; Herlev Hospital, Denmark) Journal of Applied Physiology (ISSN 8750-7587) vol. 75, no. 1 July 1993 p. 349-356. Research supported by Danish Space Board refs
Copyright

On one day six male subjects underwent an upright seated (SEAT) study, and on another day they were subjected to a head-down tilt of 3 deg (HDT). Compared with SEAT, HDT induced prompt increases in central venous pressure (CVP) from -0.5 +/- 0.8 to 8.3 +/- 0.3 mmHg and in arterial pulse pressure of 8-18 mmHg. CVP stabilized after 6 h at levels 2.4-2.8 mmHg below the peak value. Simultaneously, renal sodium excretion gradually increased over the initial 5 h of HDT and stabilized at a level about 125 micromol/min over that of SEAT. Urine flow rate and solute free water clearance increased during the initial 2-6 h of HDT but returned to the level of SEAT thereafter. We concluded that CVP is slightly reduced over 12 h of HDT and that a clear temporal dissociation exists between renal sodium and water handling. We suggest that the combined effect of the sustained suppressions of plasma renin activity and plasma aldosterone and norepinephrine concentrations constitutes a mechanism of the increase in renal sodium excretion. Author (revised)

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BEHAVIORAL SCIENCES

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

A93-49276
AB INITIO PILOT TRAINING PROCESS MORE EFFICIENT THAN TRADITIONAL METHODS
JOHN MARINO (FlightSafety International, New York) ICAO Journal (ISSN 0018-8778) vol. 48, no. 4 May 1993 p. 8, 9.
Copyright

An ab initio pilot training program that provides the ability to carefully screen and select crew candidates and train them to a specific airline's standards is discussed. Emphasis is placed on experience of Tyrolean Airways, an Innsbruck, Austria-based regional air-carrier, who participates in FlightSafety ab initio program. AIAA

A93-49404* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
MENTAL ROTATION - A KEY TO MITIGATION OF MOTION SICKNESS IN THE VIRTUAL ENVIRONMENTS?
DONALD E. PARKER (Miami Univ., Oxford, OH) and DEBORAH L. HARM (NASA, Johnson Space Center, Houston, TX) Presence: Teleoperators and Virtual Environments (ISSN 1054-7460) vol. 1, no. 3 Summer 1992 p. 329-333. refs
(Contract NAG9-446)
Copyright

If mental rotation is important for the reduction of motion sickness and complement performance in virtual environments (VEs), the use of the Howard (1982) mental rotation test battery may identify individuals with lower susceptibility to VE-induced motion sickness and therefore a greater probability of success as VE operators. An apparatus and its associated procedures are currently under development for astronaut microgravity training aimed at reducing motion sickness; it is hypothesized that this system may be of significance to VE testing and training. AIAA

A93-49406
A LITERATURE SURVEY FOR VIRTUAL ENVIRONMENTS - MILITARY FLIGHT SIMULATOR VISUAL SYSTEMS AND SIMULATOR SICKNESS
RANDY PAUSCH, THOMAS CREA, and MATTHEW CONWAY (Virginia Univ., Charlottesville) Presence: Teleoperators and Virtual Environments (ISSN 1054-7460) vol. 1, no. 3 Summer 1992 p. 344-363. Research supported by NSF, Science Applications International Corp., Virginia Engineering Foundation, and Virginia Center for Innovative Technology refs
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An overview is presented of the current understanding of motion sickness-related effects ('simulator sickness') arising in military flight simulator training, with a view to uncovering the findings most pertinent to the development of virtual environments. Attention is given to the temporal, energy, and spatial properties of simulator

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visual systems, determinations regarding susceptibility to simulator sickness according to gender, age, illness, and position in the simulator, and such aftereffects of simulator training as fatigue and relative adaptation. AIAA

A93-49563
SPATIAL ORIENTATION IN WEIGHTLESS ENVIRONMENTS
J. R. LACKNER (Brandeis Univ., Waltham, MA) Perception (ISSN 0301-0066) vol. 21, no. 6 1992 p. 803-812.
Copyright

Illusions of body inversion and of vehicle inversion can be evoked by exposure to weightlessness in the microgravity conditions of orbital and parabolic flight. Such illusions can involve all possible combinations of self-inversion and vehicle inversion. In the absence of any patterns of external stimulation, individuals may lose all sense of body orientation to their surroundings while retaining a sense of their overall body configuration and cognitive awareness of their actual position. Touch and pressure cues provide a perceptual 'down' in the absence of visual input. When vision is allowed, apparent orientation is influenced by a variety of factors including the direction of gaze, the architectural layout of the vehicle, and sight of the body. The relative importance of the various factors affecting orientation changes with repeated exposure. The virtual absence of sensations of falling during exposure to free-fall emphasizes the role of cognitive factors in experienced orientation.

A93-50338
THE PSYCHOSOCIAL ADAPTATION OF CHILDREN IN SPACE - A SPECULATION
A. R. COLON and P. A. COLON (Georgetown Univ., Washington) Journal of Practical Applications in Space (ISSN 1046-8757) vol. 3, no. 3 Spring 1992 p. 5-20. refs
Copyright

Speculations regarding the adaptation of children to the unique conditions of a space environent, extrapolated from studies of adults and data compiled by adults, are considered. It is emphasized how very speculative it is to determine the physiological state of children in 1/6 to 1 factor gravity colonies since all the physiological and stress data have been derived from zero-gravity studies for adults. AIAA

A93-51115
ANALYSIS OF INDIVIDUAL DIFFERENCES BETWEEN PSYCHOLOGICAL REACTIONS OF HUMANS UNDER COMBINED HYPOXIC STRESS [ANALIZ INDIVIDUAL'NYKH RAZLICHIJ PSIKHOLOGICHESKOJ REAKTSII CHELOVEKA NA KOMBINIROVANNOE GIPOKSICHESKOE VOZDEJSTVIE]
YU. V. BUSHOV, A. V. MAKHNACH, and K. T. PROTASOV (NII Biologii i Biofiziki, Tomsk, Russia) Fiziologiya Cheloveka (ISSN 0131-1646) vol. 19, no. 4 July-Aug. 1993 p. 97-103. In RUSSIAN refs
Copyright

In a search of suitable criteria for the selection of individuals for work under adverse climatic conditions, individual differences were investigated in 85 healthy individuals and 23 mountain climbers with respect to endurance under hypoxic conditions (40-60-min-long exposure to 3.5 km simulated altitude) combined with physical exercise. During experiments, psychological tests were conducted simultaneously with measurements of physiological parameters. Three types of reactions were identified among tested subjects, which differ by the level of the observed endurance. Subjects in the lowest adequacy group reacted to hypoxia/exercise exposure with a deterioration of the psychological state, which sometimes progressed even after the return to sea level altitude. This category was absent in the group of mountain climbers. Results of this study were used to develop a program for predicting the type of the reaction to hypoxia and the level of psychological stability of the subject. AIAA

A93-51959 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ALTERNATING PRISM EXPOSURE CAUSES DUAL ADAPTATION AND GENERALIZATION TO A NOVEL DISPLACEMENT
ROBERT B. WELCH (NASA, Ames Research Center, Moffett Field, CA), BRUCE BRIDGEMAN, SULEKHA ANAND, and KAITLIN E. BROWMAN (California Univ., Santa Cruz) Perception & Psychophysics (ISSN 0031-5117) vol. 54, no. 2 1993 p. 195-204. refs
(Contract AF-AFOSR-90-0095; RTOP 199-16-12-34)
Copyright

In two experiments, we examined the hypothesis that repeatedly adapting and readapting to two mutually conflicting sensory environments fosters the development of a separate adaptation to each situation (dual adaptation) as well as an increased ability to adapt to a novel displacement (adaptive generalization). In the preliminary study, subjects alternated between adapting their visuomotor coordination to 30-diopter prismatic displacement and readapting to normal vision. Dual adaptation was observed by the end of 10 alternation cycles. However, an unconfounded test of adaptive generalization was prevented by an unexpected prism-adaptive shift in preexposure baselines for the dual-adapted subjects. In the primary experiment, the subjects adapted and readapted to opposite 15-diopter displacements for a total of 12 cycles. Both dual adaptation and adaptive generalization to a 30-diopter displacement were obtained. These findings may be understood in terms of serial reversal learning and 'learning to learn'.

A93-52187* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HIGH LEVEL ORGANIZING PRINCIPLES FOR DISPLAY OF SYSTEMS FAULT INFORMATION FOR COMMERCIAL FLIGHT CREWS
WILLIAM H. ROGERS (Bolt Beranek and Newman, Inc., Cambridge, MA) and PAUL C. SCHUTTE (NASA, Langley Research Center, Hampton, VA) Feb. 1993 8 p. Mid-Atlantic Human Factors Conference, 1st, Virginia Beach, VA, Feb. 25, 26, 1993, Paper refs
(Contract NAS1-18788)

Advanced fault management aiding concepts for commercial pilots are being developed in a research program at NASA Langley Research Center. One aim of this program is to re-evaluate current design principles for display of fault information to the flight crew: (1) from a cognitive engineering perspective and (2) in light of the availability of new types of information generated by advanced fault management aids. The study described in this paper specifically addresses principles for organizing fault information for display to pilots based on their mental models of fault management.

A93-52301
SOME PERSONALITY AND APTITUDE CHARACTERISTICS OF AIR TRAFFIC CONTROL SPECIALIST TRAINEES
LENDELL G. NYE and WILLIAM E. COLLINS (FAA, Civil Aeromedical Inst., Oklahoma City, OK) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 8 Aug. 1993 p. 711-716. refs
Copyright

This study examined the interrelations of personality traits, aptitude test scores, and job performance self-expectations as predictors of success in the FAA Academy screening program of prospective air traffic controllers. Based on the State-Trait Personality Inventory (STPI), men and women Air Traffic Control Specialist (ATCS) trainees exhibited less anxiety and anger than normative groups of college students and Navy recruits. ATCS pass rates for 1,284 entrants were lower within each aptitude test score level for the subjects with anxiety or anger scores above the normative levels. Analyses indicated significant relationships between self-expectations of future job performance and both anxiety and aptitude test scores. Personality factors were found

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to affect the predictive validity of the primary test used for determining a student's aptitude for learning air traffic control principles and procedures.

A93-52501
DISRUPTION AND MAINTENANCE OF SKILLED VISUAL SEARCH AS A FUNCTION OF DEGREE OF CONSISTENCY
MARK D. LEE and ARTHUR D. FISK (Georgia Inst. of Technology, Atlanta) Human Factors (ISSN 0018-7208) vol. 35, no. 2 June 1993 p. 205-220. refs
(Contract F33615-88-C-0015)
Copyright

The present experiment was conducted to investigate the effects of varying degrees of task consistency on the performance and maintenance of skill in a semantic-category visual search task. Four groups of participants first received 6000 trials of consistent mapping (CM) training on two different categories. The participants then performed 4000 trials in which one of the previously trained categories remained 100 percent consistent, whereas the other previously trained category became either 100 percent, 67 percent, 50 percent, or 33 percent consistent. This second phase of the experiment allowed the examination of disruption of the search skill as a function of degree of consistency. Subsequent to the degree of consistency manipulation, 100 percent consistency was restored and participants performed another 4200 CM trials. Results indicate that performance was disrupted by inconsistency and that disruption increased as consistency decreased. On the return of task consistency, performance improved rapidly to predisruption levels, though some performance disruption was evident. Theoretical and practical implications are discussed.
Author (revised)

A93-52506* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
COCKPIT CHECKLISTS - CONCEPTS, DESIGN, AND USE
ASAF DEGANI (San Jose State Univ. Foundation, CA) and EARL L. WIENER (Miami Univ., Coral Gables, FL) Human Factors (ISSN 0018-7208) vol. 35, no. 2 June 1993 p. 345-359. refs
(Contract NCC2-377)
Copyright

Although the aircraft checklist has long been regarded as a foundation of pilot standardization and cockpit safety, it has escaped the scrutiny of the human factors profession. The improper use, or nonuse, of the normal checklist by flight crews is often cited as a major contributing factor to aircraft accidents. This paper reports the results of a field study of flight deck checklists and examines this seemingly mundane yet critical device from several perspectives: its functions, format, design, length, and usage, and the limitations of the humans who must interact with it. Certain sociotechnical factors, such as the airline 'culture', cockpit resource management, and production pressures that influence the design and use of this device, are also discussed. Finally, a list of design guidelines for normal checklists is provided. Although the focus of this paper is on the air transport industry, most of the principles discussed apply equally well to other high-risk industries, such as maritime transportation, power production, weapons systems, space flight, and medical care.

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MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

Includes human engineering; biotechnology; and space suits and protective clothing.

A93-49218
INFLUENCE OF TEMPERATURE AND METABOLIC RATE ON WORK PERFORMANCE WITH CANADIAN FORCES NBC CLOTHING
T. M. MCLELLAN, I. JACOBS, and J. B. BAIN (Defence and Civil Inst. of Environmental Medicine, North York, Canada) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 7 July 1993 p. 587-594. refs
Copyright

The effects of environmental temperature and metabolic rate (light or heavy work) on the work tolerance time of workers wearing various levels of nuclear, biological, and chemical (NBC) protective clothing were investigated in 23 unacclimatized male soldiers wearing Canadian Forces standard issue infantry NBC protective clothing or normal combat clothing. It was found that, at 18 C, all subjects wearing NBC clothing were able to complete 5 h of light work. Wearing H and doing heavy work at 18 C, reduced this work time to an average tolerance time of less than 1 h. The effect of changing the ambient temperature to 30 C compounded the severity of the problem, causing reduction of tolerance time at all levels of work.
AIAA

A93-49219
CONTINUOUS VS. INTERMITTENT WORK WITH CANADIAN FORCES NBC CLOTHING
T. M. MCLELLAN, I. JACOBS, and J. B. BAIN (Defence and Civil Inst. of Environmental Medicine, North York, Canada) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 7 July 1993 p. 595-598. refs
Copyright

This study examined the benefits of work and rest schedules on soldiers' work tolerance (WTT) while wearing various levels of nuclear, biological, chemical (NBC) defense protective clothing in a warm environment. Eight unacclimatized males were assigned to exercise at either a light or heavy metabolic rate. Subjects were tested wearing three levels of clothing protection: combat clothing (L); combats and a semipermeable NBC overgarment with the hood down (M); combats and NBC overgarment, gloves, boots, and respirator (H). For each clothing configuration, subjects were evaluated using both a 'continuous' exercise protocol and an intermittent work and rest schedule. WTT was defined as the time until rectal temperature (Tre) reached 39.3 C, heart rate reached 95 percent maximum, dizziness or nausea precluded further exercise, or 5 h had elapsed. An average metabolic rate was calculated for all trials. A decreasing hyperbolic function described the relationship between WTT and metabolic rate for M and H. These relationships facilitate quantification of appropriate work and rest schedules if the metabolic rate of a task is known.
Author (revised)

A93-49223
HELMET SLIPPAGE DURING VISUAL TRACKING - THE EFFECT OF VOLUNTARY HEAD MOVEMENTS
CATHERINE NEARY, IAIN J. BATE, LEON F. HELLER, and MARK WILLIAMS (British Aerospace, PLC, Sowerby Research Centre, Bristol, United Kingdom) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 7 July 1993 p. 623-630. Research supported by British Aerospace, PLC refs
Copyright

The influence of visual tracking on head movement and on the head/helmet system was investigated for two different helmets (a motorcycle helmet and a flying helmet) under static laboratory conditions. Subjects visually refixated between pairs of illuminated

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targets located at various horizontal and vertical distances apart while head position and helmet slippage were measured in azimuth, pitch, roll, X, Y, and Z using a double magnetic coil system. Results showed that for both helmets, rms head movement increased with refixation distance, especially in the main axis of refixation, and that rms helmet slippage can be a function of rms head motion. Further, large individual differences in the degree of head motion were found. These findings may have implications for designers and investigators of helmet-mounted avionics.
Author (revised)

A93-49302
IMPLEMENTATION OF BIOLOGICAL ELEMENTS IN LIFE SUPPORT SYSTEMS - RATIONALE AND DEVELOPMENT MILESTONES
C. TAMPONNET (ESTEC, Noordwijk, Netherlands), C. KRATSCHMANN (Oesterreichische Raumfahrt- und Systemtechnik Gesellschaft mbH, Vienna, Austria), H. HURTL, R. SACHER (Vienna Univ., Austria), H. RAMDI, and M. LIEVREMONT (Cachan, Ecole Normale Superieure, France) ESA Bulletin (ISSN 0376-4265) no. 74 May 1993 p. 71-82.
Copyright

A development status evaluation is conducted for closed biological systems-based technologies for long-duration space missions and permanent lunar or planetary space colonization. An effort is made to estimate the development periods required for technological maturity suitable for implementation is reached in this field. Attention is given to the comparative evaluation of candidate systems in terms of energy requirements, sensitivity to the space environment, mission duration/crew size accommodation, food production capacity, waste reclamation, water recycling, air regeneration, and the production of contaminants. The candidate technologies encompass enzime bioreactors; microorganism reactors; microbial air filters; cultivation of algae, fungi, or higher plants; plant cell cultures; and animal breeding. AIAA

A93-49357
DESIGNS AND DEVELOPMENT OF A MASTER-SLAVE TELEOPERATED ROBOT
N. P. GIRI (ISRO, Vikram Sarabhai Space Centre, Thiruvananthapuram, India), A. GHOSH, and K. S. RAM (Indian Inst. of Technology, Kanpur, India) *In* Intelligent robotics; Proceedings of the International Symposium, Bangalore, India, Jan. 2-5, 1991 New Delhi Tata McGraw-Hill Publishing Co., Ltd. 1991 p. 494-504. refs
Copyright

The paper discusses the design, development, and performance of a PC-based master-slave teleoperated robot. It involves the selection of the slave robot, the design and fabrication of human interface, the development of a control software, and testing. The performance of the system is evaluated, and suggestions are made for improving the efficiency of the system and extending research work. With the limitations in fabrication and instrumentation, the master slave robot system performed satisfactorily. AIAA

A93-49393
A COMPUTATIONAL MODEL FOR THE STEREOSCOPIC OPTICS OF A HEAD-MOUNTED DISPLAY
WARREN ROBINETT and JANNICK P. ROLLAND (North Carolina Univ., Chapel Hill) Presence: Teleoperators and Virtual Environments (ISSN 1054-7460) vol. 1, no. 1 Winter 1992 p. 45-62. Stereoscopic displays and applications II, Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1991, p. 140-160 Research supported by DARPA refs
(Contract DAEA18-90-C-0044; N00014-86-K-0680)
Copyright

For stereoscopic photography or telepresence, orthostereoscopy occurs when the perceived size, shape, and relative position of objects in the three-dimensional scene being viewed match those of the physical objects in front of the camera. In virtual reality, the simulated scene has no physical counterpart, so orthostereoscopy must be defined in this case as constancy, as the head moves around, of the perceived size, shape, and relative positions of the simulated objects. Achieving this constancy requires that the computational model used to generate the graphics matches the physical geometry of the head-mounted display being used. This geometry includes the optics used to image the displays and the placement of the displays with respect to the eyes. The model may fail to match the geometry because model parameters are difficult to measure accurately, or because the model itself is in error. Two common modeling errors are ignoring the distortion caused by the optics and ignoring the variation in interpupillary distance across different users. A computational model for the geometry of a head-mounted display is presented, and the parameters of this model for the VPL EyePhone are calculated.

A93-49394
TRANSFORMING HUMAN HAND MOTION FOR TELEMANIPULATION
THOMAS H. SPEETER (AT&T Bell Labs., Holmdel, NJ) Presence: Teleoperators and Virtual Environments (ISSN 1054-7460) vol. 1, no. 1 Winter 1992 p. 63-79. refs
Copyright

Manipulation by teleoperation (telemanipulation) offers an apparently straightforward and less computationally expensive route toward dextrous robotic manipulation than automated control of multifingered robotic hands. The functional transformation of human hand motions into equivalent robotic hand motions, however, presents both conceptual and analytical problems. This paper reviews and proposes algorithmic methods for transforming the actions of human hands into equivalent actions of slave multifingered robotic hands. Forward positional transformation is considered only, the design of master devices, feedforward dynamics, and force feedback are not considered although their importance for successful telemanipulation is understood. Linear, nonlinear, and functional mappings are discussed along with performance and computational considerations.

A93-49397* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
OPERATOR PERFORMANCE WITH ALTERNATIVE MANUAL CONTROL MODES IN TELEOPERATION
H. DAS, H. ZAK, W. S. KIM, A. K. BEJCZY, and P. S. SCHENKER (JPL, Pasadena, CA) Presence: Teleoperators and Virtual Environments (ISSN 1054-7460) vol. 1, no. 2 Spring 1992 p. 201-218. refs
Copyright

Recent experiments conducted at the JPL comparing alternative manual control modes using the JPL Advanced Teleoperator system are described. Of particular interest were control modes that provide force reflection to the operator. The task selected for the experiment is a portion of the Solar Maximum Satellite Repair procedure we developed to demonstrate the repair of the Solar Maximum Satellite with teleoperators. The seven manual control modes evaluated in the experiment are combinations of manual position or resolved motion rate control with alternative control schemes for force reflection and remote manipulator compliance. Performance measures used were task completion times, average force and torque exerted during the execution of the task, and cumulative force and torque exerted. The results were statistically analyzed and they show that, in general, force reflection significantly improves operator performance and indicate that a specific force-reflecting scheme may yield the best performance among the control modes we tested. Also, our experiment showed that, for the selected task, the position control modes were preferable to the rate control modes and slave manipulator compliance reduced task interaction forces and torques. Author (revised)

A93-49398
SYNTHETIC EXPERIENCE - A PROPOSED TAXONOMY
WARREN ROBINETT (North Carolina Univ., Chapel Hill) Presence: Teleoperators and Virtual Environments (ISSN 1054-7460) vol. 1, no. 2 Spring 1992 p. 229-247. Research supported by

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DARPA refs
(Contract DAEA18-90-C-0044; NSF ASC-89-20219; NIH-5-R24-RR-02170; N00014-86-K-0680)
Copyright

A taxonomy is proposed to classify all varieties of technologically mediated experience. This includes virtual reality and teleoperation, and also earlier devices such as the microscope and telephone. The model of mediated interaction assumes a sensor-display link from the world to the human, and an action-actuator link going back from the human to the world, with the mediating technology transforming the transmitted experience in some way. The taxonomy is used to classify a number of example systems. Two taxonomies proposed earlier are compared with the ideas presented in this paper. Then the long-term prospects of this field are speculated on, ignoring constraints of cost, effort, or time to develop. Finally, the ultimate limits of synthetic experience are discussed, which derive from properties of the physical universe and the human neural apparatus.

A93-49405
WILL SIMULATION SICKNESS SLOW DOWN THE DIFFUSION OF VIRTUAL ENVIRONMENT TECHNOLOGY?
FRANK BIOCCA (North Carolina Univ., Chapel Hill) Presence: Teleoperators and Virtual Environments (ISSN 1054-7460) vol. 1, no. 3 Summer 1992 p. 334-343. refs
Copyright

The widespread diffusion of immersive virtual environments (VE) is threatened by persistent reports that some users experience simulation sickness, a form of motion sickness that accompanies extended use of the medium. Experience with the problem of simulation sickness is most extensive in the military where the illness has accompanied the use of various simulators since the 1950s. This article considers the obstacles presented by simulation sickness to the diffusion of VE systems, its physiological and technological causes, and, finally, the remedies that have been suggested to fix the problems. This issue is also considered in light of previous reports of purported illnesses that accompanied the diffusion of other communication technologies.

A93-49443* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
INTERACTIVE AND COOPERATIVE SENSING AND CONTROL FOR ADVANCED TELEOPERATION
SUKHAN LEE (JPL, Pasadena; Southern California Univ., Los Angeles, CA), EDUARDO ZAPATA (Southern California Univ., Los Angeles, CA), and PAUL S. SCHENKER (JPL, Pasadena, CA) *In* Sensor fusion IV: Control paradigms and data structures; Proceedings of the Meeting, Boston, MA, Nov. 12-15, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 516-530. refs
Copyright

This paper presents the paradigm of interactive and cooperative sensing and control as a fundamental mechanism of integrating and fusing the strengths of man and machine for advanced teleoperation. The interactive and cooperative sensing and control is considered as an extended and generalized form of traded and shared control. The emphasis of interactive and cooperative sensing and control is given to the distribution of mutually nonexclusive subtasks to man and machine, the interactive invocation of subtasks under the man/machine symbiotic relationship, and the fusion of information and decision-making between man and machine according to their confidence measures. The proposed interactive and cooperative sensing and control system is composed of such major functional blocks as the logical sensor system, the sensor-based local autonomy, the virtual environment formation, and the cooperative decision-making between man and machine. A case study is performed to demonstrate the feasibility of implementing the fundamental theory and system architecture of interactive and cooperative sensing and control, proposed for the new generation of teleoperation.

A93-49445* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
PHYSICAL AND DIGITAL SIMULATIONS FOR IVA ROBOTICS
ELAINE HINMAN (NASA, Marshall Space Flight Center, Huntsville, AL) and GARY L. WORKMAN (Alabama Univ., Huntsville) *In* Sensor fusion IV: Control paradigms and data structures; Proceedings of the Meeting, Boston, MA, Nov. 12-15, 1991 Bellingham, WA Society of Photo-Optical Instrumentation Engineers 1992 p. 642-653. refs
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Space based materials processing experiments can be enhanced through the use of IVA robotic systems. A program to determine requirements for the implementation of robotic systems in a microgravity environment and to develop some preliminary concepts for acceleration control of small, lightweight arms has been initiated with the development of physical and digital simulation capabilities. The physical simulation facilities incorporate a robotic workcell containing a Zymark Zymate II robot instrumented for acceleration measurements, which is able to perform materials transfer functions while flying on NASA's KC-135 aircraft during parabolic manuevers to simulate reduced gravity. Measurements of accelerations occurring during the reduced gravity periods will be used to characterize impacts of robotic accelerations in a microgravity environment in space. Digital simulations are being performed with TREETOPS, a NASA developed software package which is used for the dynamic analysis of systems with a tree topology. Extensive use of both simulation tools will enable the design of robotic systems with enhanced acceleration control for use in the space manufacturing environment.

A93-49451
VISUAL DATA INTERPRETATION; PROCEEDINGS OF THE MEETING, SAN JOSE, CA, FEB. 10-11, 1992
JOANNA R. ALEXANDER, ED. (David Sarnoff Research Center, Princeton, NJ) Bellingham, WA Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings. Vol. 1668) 1992 166 p. No individual items are abstracted in this volume
(SPIE-1668; ISBN 0-8194-0822-0) Copyright

The present volume on virtual reality and scientific visualization addresses developing technology for virtual environments, virtual environment applications, scientific visualization applications, visualization approaches to complex problems, and algorithm development for visualization techniques. Attention is given to an image-based panoramic virtual reality system, virtual reality as a tool for cross-cultural communication using an example from military team training, visualization of engineering data, two approaches to combining visual and IR images for sensor fusion, and hardware-specific image-compression techniques for the animation of CFD data. AIAA

A93-49564* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
DEPTH-DOSE EQUIVALENT RELATIONSHIP FOR COSMIC RAYS AT VARIOUS SOLAR MINIMA
G. D. BADHWAR, F. A. CUCINOTTA, and P. M. O'NEILL (NASA, Johnson Space Center, Houston, TX) Radiation Research (ISSN 0033-7587) vol. 134, no. 1 April 1993 p. 9-15.
Copyright

Galactic cosmic rays (GCR) pose a serious radiation hazard for long-duration missions. In designing a lunar habitat or a Mars transfer vehicle, the radiation exposure determines the GCR shielding thickness, and hence the weight of spacecraft. Using the spherically symmetric diffusion theory of the solar modulation of GCR, and data on the differential energy spectra of H, He, O, and Fe, from 1965 to 1989, it has been shown that (1) the flux is determined by the diffusion parameter which is a function of the time in the solar cycle, and (2) the fluxes in the 1954 and 1976-1977 solar minima were similar and higher than those in 1965. In this paper, we have extended the spherical solar modulation theory back to 1954. The 1954-1955 GCR flux was nearly the same as that from 1976 to 1977; the 1965 flux values were nearly the same as those in 1986. Using this theory we have obtained the GCR spectra for all the nuclei, and calculated the depth dose as

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a function of Al thickness. It is shown that the shielding required to stay below 0.5 Sv is 17.5 -3/+8 g/sq cm of Al, and 9 -1.5/+5 g/sq cm to stay below 0.6 Sv. The calculated dose equivalent using the ICRP 60 values for quality factors is about 15 percent higher than that calculated using the ICRP 26 value.
Author (revised)

A93-49607
COMMENT ON 'OPTIMUM VEHICLE ACCELERATION PROFILE FOR MINIMUM HUMAN INJURY' BY C. P. HATSELL
P. K. A. MENON (Optimal Synthesis, Palo Alto, CA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090) vol. 16, no. 5 Sept.-Oct. 1993 p. 991. refs
Copyright

Hatsell (1992) considered the problem of determining optimal thrust profile for an ejection seat that will minimize human injury by keeping the dynamic response index below a safe level. Here, an engineering note by Menon and Walker (1985) on 'Optimal catapult impulse shaping for ejection seats' is brought to attention and the results given in the note are compared with of Hatsell.
AIAA

A93-50513* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
A PROCEDURE FOR THE FREQUENCY ANALYSIS OF TELEROBOTIC TASKS DATA
PAOLO FIORINI (JPL, Pasadena, CA) and ANTONIO GIANCASPRO (CNR, Ist. per le Tecnologie Informatiche Spaziale, Matera, Italy) *In* 1992 IEEE/RSJ International Conference on Intelligent Robots and Systems, Raleigh, NC, July 7-10, 1992, Proceedings. Vol. 2 New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 873-880. refs
Copyright

In the last few years, teleoperated tasks have been the subject of extensive research to determine the best combination of control modalities according to specific criteria. The operator's performance were compared on the basis of task completion time and of force and torque measurements during the tasks. This paper proposes a procedure for the spectral analysis of force and torque signals generated during teleoperation experiments. There are two main reasons for examining teleoperation data in the frequency domain: a spectral analysis of different tasks can validate the assumptions made in the design of the teleoperator, and a task's frequency signature can be a valuable measure of the operator's performance.
Author (revised)

A93-50592* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
GROUND-REMOTE CONTROL FOR SPACE STATION TELEROBOTICS WITH TIME DELAY
PAUL G. BACKES (JPL, Pasadena, CA) *In* Guidance and control 1992; Proceedings of the 15th Annual AAS Rocky Mountain Conference, Keystone, CO, Feb. 8-12, 1992 San Diego, CA Univelt, Inc. 1992 p. 285-303. refs
(AAS PAPER 92-052) Copyright

The study proposes a ground-remote telerobot control architecture which could be used for control of Space Station Freedom manipulators. The architecture provides two local-site operator control stations representing potential earth-based and remote Space Station-based operator control stations. A unified control system at the remote site provides autonomous, shared, and teleoperation control for single-and dual-arm task execution. An operational laboratory system which demonstrates the feasibility of various technologies in the proposed architecture, including teleoperation, shared control, and supervised autonomy, is described. Enhancements to the system currently under development, including remote site implementation in Ada, integration and control of a redundant 7-DOF manipulator, and local site advanced operator aids, are also described. AIAA

A93-50593* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
TELEROBOT CONTROL MODE PERFORMANCE ASSESSMENT
WAYNE ZIMMERMAN, PAUL BACKES (JPL, Pasadena, CA), and GREG CHIRIKJIAN (California Inst. of Technology, Pasadena) *In* Guidance and control 1992; Proceedings of the 15th Annual AAS Rocky Mountain Conference, Keystone, CO, Feb. 8-12, 1992 San Diego, CA Univelt, Inc. 1992 p. 305-318. refs
(AAS PAPER 92-053) Copyright

With the maturation of various developing robot control schemes, it is becoming extremely important that the technical community evaluate the performance of these various control technologies against an established baseline to determine which technology provides the most reliable robust, and safe on-orbit robot control. The Supervisory Telerobotics Laboratory (STELER) at JPL has developed a unique robot control capability which has been evaluated by the NASA technical community and found useful for augmenting both the operator interface and control of intended robotic systems on-board the Space Station. As part of the technology development and prototyping effort, the STELER team has been evaluating the performance of different control modes; namely, teleoperation under position, or rate, control, teleoperation with force reflection and shared control. Nine trained subjects were employed in the performance evaluation involving several high fidelity servicing tasks. Four types of operator performance data were collected; task completion time, average force, peak force, and number of operator successes and errors. This paper summarizes the results of this performance evaluation.

A93-50594
A MANIPULATOR CONTROL TESTBED - IMPLEMENTATION AND APPLICATIONS
JOHN FIALA, ALBERT WAVERING, and RONALD LUMIA (NIST, Gaithersburg, MD) *In* Guidance and control 1992; Proceedings of the 15th Annual AAS Rocky Mountain Conference, Keystone, CO, Feb. 8-12, 1992 San Diego, CA Univelt, Inc. 1992 p. 319-334. refs
(AAS PAPER 92-054)

An implementation of the lower levels of the NASA/NIST Standard Reference Model (NASREM) Telerobot Control System Architecture has been developed at NIST. The implementation includes manipulator servo control, rate teleoperation, autonomous trajectory generation, and visual sensing. This paper describes how the system is designed to be a testbed for manipulator control via generic interfaces and a modular Ada software architecture. The multiprocessor hardware architecture which supports the software architecture for real-time operation is also described. The paper presents applications of the testbed system to specific manipulator control problems, including some example comparisons of different strategies for servo control and trajectory generation.

A93-50596
OPTIMIZING DYNAMIC TRANSPARENCY IN TELEOPERATOR ARCHITECTURES
DALE A. LAWRENCE (Colorado Univ., Boulder) *In* Guidance and control 1992; Proceedings of the 15th Annual AAS Rocky Mountain Conference, Keystone, CO, Feb. 8-12, 1992 San Diego, CA Univelt, Inc. 1992 p. 353-365. refs
(AAS PAPER 92-056) Copyright

A system-theoretic approach is discussed for the analysis and design of bilateral teleoperation systems to optimize transparency in task interaction. A general system architecture is utilized which uses all four types of data transmission between master and slave: force and position in both directions. It is shown that a proper use of all four channels is of critical importance in achieving high performance telepresence in the sense of accurate transmission of task impedances to the operator. Achieved transparency and stability properties of two common architectures, as well as a new 'transparency optimized' architecture, are compared in a simplified one degree of freedom analysis.

A93-51449#
THEORETICAL AND EXPERIMENTAL STUDIES FOR CONTINUOUS PATH CONTROL OF FLEXIBLE MANIPULATOR MOUNTED ON A FREE-FLYING SPACE ROBOT
YOSHISADA MUROTSU, KEI SENDA, AKIRA MITSUYA, KEISUKE

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YAMANE (Osaka Prefecture Univ., Sakai, Japan), and TATSUYA NUNOHARA (Kyokuto Kaihatsu Kogyo Co., Ltd., Japan) *In* AIAA Guidance, Navigation and Control Conference, Monterey, CA, Aug. 9-11, 1993, Technical Papers. Pt. 3 Washington American Institute of Aeronautics and Astronautics 1993 p. 1458-1471. Research supported by MOESC refs
(AIAA PAPER 93-3863) Copyright

Some continuous path tracking control schemes for flexible manipulators are proposed by using a concept of virtual rigid manipulator. An extended local PD-control (extended LPDC), pseudo resolved motion rate control (pseudo RMRC), and pseudo resolved acceleration control (pseudo RAC) for flexible manipulators are presented. To suppress vibrating motion, a composite control with a reduced-order modal control is developed. To verify the stability, a sufficient condition for asymptotic stability of PD-control is derived. It is also clarified that the PD-control damps all the vibration modes irrespective of their natural damping. The validity of the proposed control schemes is explained through the singular perturbation method. The robust stability of the proposed control schemes is discussed. The effectiveness of the proposed control schemes is demonstrated through hardware experiments using a flexible manipulator mounted on a free-flying satellite.

A93-51450#
MOTION PLANNING OF A DUAL-ARM FREE-FLOATING MANIPULATOR WITH INERTIALLY FIXED BASE
SUNIL K. AGRAWAL and SHRAVAN SHIRUMALLA (Ohio Univ., Athens) *In* AIAA Guidance, Navigation and Control Conference, Monterey, CA, Aug. 9-11, 1993, Technical Papers. Pt. 3 Washington American Institute of Aeronautics and Astronautics 1993 p. 1472-1481. Research supported by NSF refs
(AIAA PAPER 93-3864) Copyright

A scheme for joint and Cartesian motion planning of a dual arm free-floating planar roots is presented using position and rate kinematic equations so that the base of the robot remains inertially fixed. Even though free-floating manipulators are characterized by nonholonomic constraints, it is shown that the inverse position kinematics coupled with an iterative search procedure results in identical path predicted by direct integration of the rate equations. It is shown that singularities can be easily avoided. AIAA

A93-51452#
A SPACE MANIPULATOR WITH INERTIALLY FIXED BASE?
MICHAEL STIEBER and PHUNG NGUYEN (Canadian Space Agency, Saint-Hubert, Canada) *In* AIAA Guidance, Navigation and Control Conference, Monterey, CA, Aug. 9-11, 1993, Technical Papers. Pt. 3 Washington American Institute of Aeronautics and Astronautics 1993 p. 1492-1498. refs
(AIAA PAPER 93-3866) Copyright

At the heart of the Canadian contribution to Space Station 'Freedom' are two manipulator systems: The Space Station Remote Manipulator System and the Special Purpose Dexterous Manipulator. The payload handling performance requirements for these manipulators are specified assuming an inertially fixed operating base, which is equivalent to assuming an infinitely large Space Station. This paper examines the reasons for, and the effects of this seemingly unrealistic assumption which has been the subject of considerable debate within the Space Station Freedom Program. It is demonstrated that this assumption represents a worst case with respect to key parameters of the actual on-orbit manipulator performance. It is further shown why this assumption does not affect the manipulator control system design. Interaction effects between the Space Station attitude control system and the manipulators are included in the discussion and it is shown that in certain respects the 'fixed base assumption' is also a worst case assumption for the interactions of manipulators and the Space Station attitude control system.

A93-51460# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HUMAN-IN-THE-LOOP EVALUATION OF RMS ACTIVE DAMPING AUGMENTATION
MARTHA E. DEMEO (Vigyan, Inc., Hampton, VA), MICHAEL G. GILBERT, MICHAEL A. SCOTT (NASA, Langley Research Center, Hampton, VA), JANET A. LEPANTO (Charles Stark Draper Lab., Inc., Cambridge, MA), ELIZABETH M. BAINS (NASA, Johnson Space Center, Houston, TX), and MARY C. JENSEN (Lockheed Engineering & Sciences Co., Houston, TX) *In* AIAA Guidance, Navigation and Control Conference, Monterey, CA, Aug. 9-11, 1993, Technical Papers. Pt. 3 Washington American Institute of Aeronautics and Astronautics 1993 p. 1571-1581. refs
(AIAA PAPER 93-3875)

Active Damping Augmentation is the insertion of Controls-Structures Integration Technology to benefit the on-orbit performance of the Space Shuttle Remote Manipulator System. The goal is to reduce the vibration decay time of the Remote Manipulator System following normal payload maneuvers and operations. Simulation of Active Damping Augmentation was conducted in the realtime human-in-the-loop Systems Engineering Simulator at the NASA Johnson Space Center. The objective of this study was to obtain a qualitative measure of operational performance improvement from astronaut operators and to obtain supporting quantitative performance data. Sensing of vibratory motions was simulated using a three-axis accelerometer mounted at the end of the lower boom of the Remote Manipulator System. The sensed motions were used in a feedback control law to generate commands to the joint servo mechanisms which reduced the unwanted oscillations. Active damping of the Remote Manipulator System with an attached 3990 lb. payload was successfully demonstrated. Six astronaut operators examined the performance of an Active Damping Augmentation control law following single-joint and coordinated six-joint translational and rotational maneuvers. Active Damping Augmentation disturbance rejection of Orbiter thruster firings was also evaluated. Significant reductions in the dynamic response of the 3990 lb. payload were observed. Astronaut operators recommended investigation of Active Damping Augmentation benefits to heavier payloads where oscillations are a bigger problem (e.g. Space Station Freedom assembly operators).

A93-52300
SPATIAL CONTRAST SENSITIVITY THROUGH AVIATOR'S NIGHT VISION IMAGING SYSTEM
JEFF RABIN (U.S. Army, Aeromedical Research Lab., Fort Rucker, AL) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 8 Aug. 1993 p. 706-710. refs
Copyright

Visual acuity is often used to assess vision through image intensifying devices such as night vision goggles (NVGs). Fewer attempts have been made to measure contrast sensitivity through NVGs. In this study, computer-generated letter charts were used to measure contrast sensitivity through third generation NVGs for a range of letter sizes. The red phosphor of a standard color monitor proved to be an effective stimulus for third generation devices. Different night sky conditions were simulated over a 3 log unit range. The results illustrate the profile of contrast sensitivity through third generation NVGs over a range of night sky conditions. Comparison of measurements through NVGs to measurements obtained without the device but at the same luminance and color distinguish between effects of luminance and noise on contrast sensitivity. Author (revised)

A93-52308
FATAL MISHAP REPORT - FIRST SPH-4B FLIGHT HELMET RECOVERED FROM A U.S. ARMY HELICOPTER MISHAP
JAMES E. BRUCKART, B. J. MCENTIRE, JOSEPH R. LICINA, DOUGLAS K. BRANTLEY, and DENNIS SHANAHAN (U.S. Army, Aeromedical Research Lab., Fort Rucker, AL) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 8 Aug. 1993 p. 755-759. refs
Copyright

Consideration is given to the first SPH-4B flight helmet recovered from a fatal mishap which was correlated with the injuries to the wearer. The new shell and liner reduced the impact forces to the head. There were no side impacts to determine the

performance of the crushable earcups in the helmet. The new SPH-4B flight helmet is characterized by new and distinctive features that make it possible to improve survival in future helicopter crashes. AIAA

A93-52309
MONITORING CORE TEMPERATURE DURING EXERCISE - INGESTIBLE SENSOR VS. RECTAL THERMISTOR
PHILLIP B. SPARLING, TERESA K. SNOW, and MINDY L. MILLARD-STAFFORD (Georgia Inst. of Technology, Atlanta) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 8 Aug. 1993 p. 760-763. refs
Copyright

A telemetry monitoring system using an ingestible temperature sensor has recently become available commercially, but to our knowledge no published data on exercise applications have been reported. Consequently, core temperature was measured by both ingestible capsule sensors and standard rectal thermistors in six trained subjects (three cyclists, three runners) during 30 to 90 min of progressive cycling or treadmill exercise. Testing was conducted 3-9 h after ingestion of the capsule. The telemetered temperature was lower than the rectal temperature both at rest and during exercise in every subject, with resulting significant mean differences (+/- S.D.) of 36.91 (+/- 0.41) vs. 37.50 (+/- 0.21) and 38.01 (+/- 0.33) vs. 38.94 C (+/- 0.24), respectively. The mean temperature difference increased by 58 percent from rest (0.59 C) to peak exercise (0.93 C). Author (revised)

A93-52406 National Aeronautics and Space Administration, Washington, DC.
HUMAN LOCOMOTION AND WORKLOAD FOR SIMULATED LUNAR AND MARTIAN ENVIRONMENTS
DAVA J. NEWMAN and HAROLD L. ALEXANDER (MIT, Cambridge, MA) Acta Astronautica (ISSN 0094-5765) vol. 29, no. 8 Aug. 1993 p. 613-620. IAF, International Astronautical Congress, 42nd, Montreal, Canada, Oct. 5-11, 1991, IAF Paper 91-561. Previously cited in issue 05, p. 764, Accession no. A92-18556 Research supported by NASA refs
(Contract NGT-50512)
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A93-52410
THE FIRST 'SPACE' VEGETABLES HAVE BEEN GROWN IN THE 'SVET' GREENHOUSE USING CONTROLLED ENVIRONMENTAL CONDITIONS
T. N. IVANOVA (Bulgarian Academy of Sciences, Space Research Inst., Sofia, Bulgaria), YU. A. BERKOVICH, A. L. MASHINSKIJ, and G. I. MELESHKO (Inst. of Biomedical Problems, Moscow, Russia) Acta Astronautica (ISSN 0094-5765) vol. 29, no. 8 Aug. 1993 p. 639-644. IAF, International Astronautical Congress, 42nd, Montreal, Canada, Oct. 5-11, 1991, IAF Paper 91-575. Previously cited in issue 05, p. 764, Accession no. A92-18565 refs
Copyright

A93-52411
CELSS NUTRITION SYSTEM UTILIZING SNAILS
Y. MIDORIKAWA (JGC Corp., Tokyo, Japan), T. FUJII (JGC Corp., Planning and Business Development Office, Tokyo, Japan), A. OHIRA (Inst. of Highland Agriculture, Tokyo, Japan), and K. NITTA (National Aerospace Lab., Tokyo, Japan) Acta Astronautica (ISSN 0094-5765) vol. 29, no. 8 Aug. 1993 p. 645-650. IAF, International Astronautical Congress, 42nd, Montreal, Canada, Oct. 5-11, 1991, IAF Paper 91-576. Previously cited in issue 05, p. 764, Accession no. A92-18566 refs
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A93-52502* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
MODELING STRATEGIC BEHAVIOR IN HUMAN-AUTOMATION INTERACTION - WHY AN 'AID' CAN (AND SHOULD) GO UNUSED
ALEX KIRLIK (Georgia Inst. of Technology, Atlanta) Human Factors (ISSN 0018-7208) vol. 35, no. 2 June 1993 p. 221-242. refs
(Contract NAG2-656; NAG2-195)
Copyright

Task-offload aids (e.g., an autopilot, an 'intelligent' assistant) can be selectively engaged by the human operator to dynamically delegate tasks to automation. Introducing such aids eliminates some task demands but creates new ones associated with programming, engaging, and disengaging the aiding device via an interface. The burdens associated with managing automation can sometimes outweigh the potential benefits of automation to improved system performance. Aid design parameters and features of the overall multitask context combine to determine whether or not a task-offload aid will effectively support the operator. A modeling and sensitivity analysis approach is presented that identifies effective strategies for human-automation interaction as a function of three task-context parameters and three aid design parameters. The analysis and modeling approaches provide resources for predicting how a well-adapted operator will use a given task-offload aid, and for specifying aid design features that ensure that automation will provide effective operator support in a multitask environment.

A93-52503
REAL-TIME EXPERT SYSTEM INTERFACES, COGNITIVE PROCESSES, AND TASK PERFORMANCE - AN EMPIRICAL ASSESSMENT
LEONARD ADELMAN, MARVIN S. COHEN, TERRY A. BRESNICK, JAMES O. CHINNIS, JR., and KATHRYN B. LASKEY (Decision Science Consortium, Inc., Reston, VA) Human Factors (ISSN 0018-7208) vol. 35, no. 2 June 1993 p. 243-261. refs
(Contract MDA903-85-C-0332)
Copyright

In this experiment we investigated the effect of different real-time expert system interfaces on operators' cognitive processes and performance. The results supported the principle that a real-time expert system's interface should focus operators' attention on where it is required most. However, following this principle resulted in unanticipated consequences. In particular, it led to inferior performance for less critical, yet important cases requiring operators' attention. For such cases operators performed better with an interface that let them select where they wanted to focus their attention. Having a rule generation capability improved performance with all interfaces but did so less than hypothesized. In all cases performance with different interfaces and a rule generation capability was explained by the effect of the interfaces on cognitive process measures.

A93-52504
RECOMMENDATIONS FOR MENTAL WORKLOAD MEASUREMENT IN A TEST AND EVALUATION ENVIRONMENT
W. W. WIERWILLE (Virginia Polytechnic Inst. and State Univ., Blacksburg) and F. T. EGGEMEIER (Dayton Univ., OH) Human Factors (ISSN 0018-7208) vol. 35, no. 2 June 1993 p. 263-281. refs
Copyright

Research performed during the last decade on estimation of mental workload has resulted in a subset of techniques exhibiting global sensitivity. Other techniques have also been demonstrated to have sensitivity in particular applications and can be used for diagnostic purposes. This paper reviews techniques that have shown sufficient sensitivity and robustness to be used in test and evaluation. Topics such as time scale considerations, available documentation, and appropriate procedures are also discussed. Recommendations are then made for workload estimation in test and evaluation situations.

A93-52507* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
HEADPHONE LOCALIZATION OF SPEECH
DURAND R. BEGAULT and ELIZABETH M. WENZEL (NASA, Ames Research Center, Moffett Field, CA) Human Factors (ISSN

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0018-7208) vol. 35, no. 2 June 1993 p. 361-376. Research supported by NASA, National Research Council, and FAA refs
Copyright

Three-dimensional acoustic display systems have recently been developed that synthesize virtual sound sources over headphones based on filtering by head-related transfer functions (HRTFs), the direction-dependent spectral changes caused primarily by the pinnae. In this study, 11 inexperienced subjects judged the apparent spatial location of headphone-presented speech stimuli filtered with nonindividualized HRTFs. About half of the subjects 'pulled' their judgments toward either the median or the lateral-vertical planes, and estimates were almost always elevated. Individual differences were pronounced for the distance judgments; 15 to 46 percent of stimuli were heard inside the head, with the shortest estimates near the median plane. The results suggest that most listeners can obtain useful azimuth information from speech stimuli filtered by nonindividualized HRTFs. Measurements of localization error and reversal rates are comparable with a previous study that used broadband noise stimuli. Author (revised)

A93-52641
MACHINE VISION IN SPACE

S. G. MACLEAN (Canadian Space Agency, Ottawa, Canada) and H. F. L. PINKNEY (National Research Council of Canada, Inst. of Aerospace Research, Ottawa) Canadian Aeronautics and Space Journal (ISSN 0008-2821) vol. 39, no. 2 June 1993 p. 63-77. refs

The paper describes the Space Vision System (SVS) experiments, conducted in October 1992, when this machine vision system was flown for ten days on STS-52 as part of the Canex-2 series of experiments. The experiments covered many of the baseline requirements for the Artificial Vision Unit, which will play a major role in both the manual and operational control of the manipulators and cameras, and showed that integrated machine vision manipulator operations are not only feasible but perhaps desirable. The SVS allowed the operator to control the Canadarm with more precision than before. Technical data show that the quality of the integrated Shuttle's closed-circuit television system/SVS image plane data approach the theoretical limit. It is concluded that this system can support rendezvous operations when the Shuttle cameras are upgraded. AIAA

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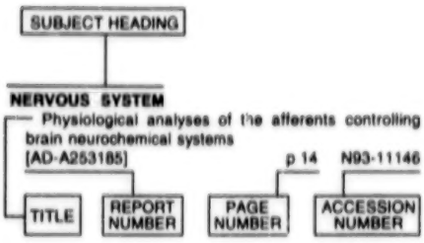

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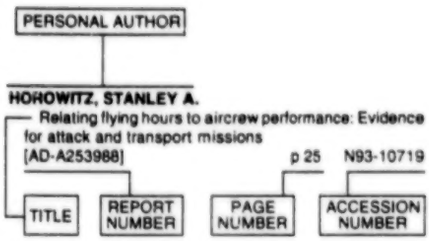

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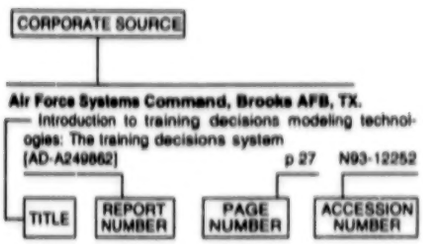

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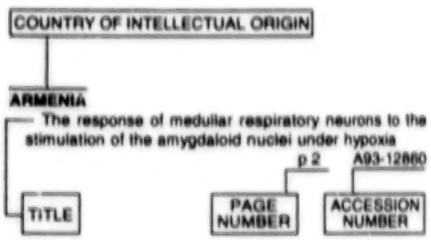
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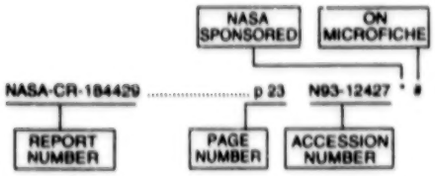

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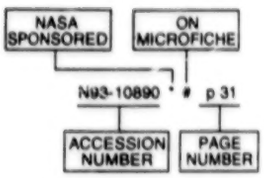

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